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A UNIVERSAL LAW[1]

Now that we appreciate fully that physics, geology, engineering, physiology, medicine, botany, zoology and biology are sub-divisions of the broader science of chemistry, we see that the chemist of the future must know a great deal more than any of us now do if he is to keep in touch with the whole subject. Many people believe that this is impossible and that the scientific man of the future will be a narrow specialist, knowing only a small part of a single division of one science. I do not believe this. As we look back over the history of any science, we see always two opposing tendencies—one that complicates and one that simplifies. The discovery of new facts makes a subject more complex and more difficult to grasp. The discovery of new relations simplifies matters because it enables us to correlate facts and thus to get a better grasp of the subject.[2]

In the chemistry of to-day we have three great, simplifying generalizations which are familiar to all of you: the atomic theory, the periodic law and the phase rule. These have long since proved their value as a means of correlating facts and as working hypotheses enabling us to predict new facts. The value of these is not great, however, when we get beyond what is called chemistry in the narrower sense of the word.

As one universal law we have the great, simplifying generalization known as the

[1] Address of the retiring president of the American Chemical Society at Minneapolis, December 28, 1910.

[2] Cf. Bancroft, *Proc. Elisha Mitchell Soc.*, 20, 39, 1904.

law of the conservation of energy. The marvelous effect of this in enabling one to correlate and remember apparently unrelated facts was brought out in a most striking way in Kundt's lectures on physics.

I wish to call your attention to-night to what I believe to be another universal law, a qualitative one and not a quantitative one. The chemists call it the theorem of Le Chatelier. The physicists call it the theorem of De Maupertuis or the principle of least action. By the biologists it is known as the law of the survival of the fittest, while the business man speaks of the law of supply and demand. The broadest definition of it is that a system tends to change so as to minimize an external disturbance.

In chemistry proper and in physics we study chiefly the effects of temperature, pressure, concentrations, electricity and light; but in the natural-history sciences we must also take account of moisture, food and fertilizers, secretions, climate, etc.

If we heat a liquid we convert a portion of the liquid into vapor, an operation which absorbs heat. If we heat a saturated solution, the solubility increases if the solid dissolves with an absorption of heat. If we increase the pressure on a dissociating compound or if we increase the concentration of the dissociation products, we get a decrease of dissociation which involves a decrease in pressure and a decrease in the amount of the dissociation product. If we pass an electric current through a solution, we tend to get a counter-electromotive force which cuts down the electrical stress. If we have suspended particles in a liquid, a difference of potential causes them to move in the direction which reduces the electrical stress. Since all substances absorb light of some wavelength to a greater or less extent, all substances are light-sensitive to some rays and tend to change in such a way as to eliminate the strain caused by the light. Whether any measurable change takes place depends on other conditions. With some silver salts or with Eder's solution of mercuric oxalate, we get visible decomposition. With chromium salts we get no measurable change unless some reducing agent is present. With some substances we get fluorescence or phosphorescence, but ordinarily without apparent change. With a copper sulphate solution there is apparently no effect due to light. Yet all these solutions are really light-sensitive and they all tend to change in the same way, namely, to eliminate the substance which absorbs the light.

In the business world continuous overproduction of any commodity necessitates a fall in the price of the article. Also, a sufficiently wide-spread and prolonged decrease in the demand for meat will bring down the price, at least temporarily. This may not help the consumer, because he may have to pay more for fish, eggs and vegetables; but that is not our problem.

If one should ship enough copper abroad as export copper and should bring it back as ballast, one would create a state of strain which would eventually play havoc with the price of copper. It is said that this experiment was tried when the price of copper was over twenty cents; but the details have never been published. Overproduction of silver destroyed the ratio of sixteen to one, while over-production of gold is now said to be one of the factors in the high cost of living.

In physiology and medicine we find many illustrations of our law. "When irritating substances get into the eye, a flow of tears occurs to wash them away; from the nose and respiratory passages, they are ejected by sneezing or by cough;

and from the stomach or intestines they are removed by the vomiting and purging to which they themselves give rise.[3]

If a splinter lodges in one's finger and is not removed, festering occurs and the splinter is sloughed out. The throwing off of a cold is merely the elimination by the system of the disturbing factors and the same may be said about the recovery from any disease. Herter[4] says that "disease is generally the expression of a reaction on the part of the cell to injurious influences."

When studying chemical reactions, we find some cases, such as the inversion of sugar, in which the reaction products have little or no effect on the reaction. In many other cases, the reaction may come to an end if the reaction products are not removed. In these latter cases the reaction products might be said to be toxic to the system. Analogous cases occur in physiology. Some secretions or reaction products are not toxic to the system, while others are. Brunton[5] says that "cells excrete poisons formed within their bodies . . . [and that] an excessive quantity of their own products is usually injurious to cells." We all know that the waste products of digestion must be removed from the intestines periodically or poisoning will ensue, and we also know that the system tends to react in such a way as to remove these products.

In the cases thus far considered, it has been fairly clear what the response of the system would be; but this is not always so. If a man goes out into the street and slaps another man's face, he creates a state of strain, which may be relieved by the other man's running away. It is quite possible, however, that the other man may knock the first man down, or he may hand the first man over to a policeman, if one happens to be near. What happens depends on the relative sizes and temperaments of the two men and on the nearness of the policeman. We can not make *A*, *B* and *C* represent the first man, the other man and the policeman, and then interchange the letters. We have the same thing in mixtures of three liquids. If we add one liquid to another, we always lower the vapor pressure of the second to a certain extent. We can not make any such definite statement about what will happen if we add a third liquid to the other two. The addition of the third liquid may decrease the partial pressures of both the other liquids or it may decrease the partial pressure of either one and increase that of the other. We must know the specific properties of the liquids before we can predict what will happen.

We know that an irritating substance is often removed from the stomach by vomiting; but if we administer poison continuously for a long time, the system tends to eliminate the irritating effect by becoming immune to the poison. We need not hark back to the mythical case of Mithridates, who qualified for the throne by living on all the known poisons while young. The case of the arsenic eaters is better authenticated.[6] The whole of immuno-chemistry is an illustration of the applicability of our law.[7]

The most interesting field for the study of our law is to be found in the natural history sciences. Here we must consider the survival of the race as well as the survival of the individual or we shall make

[3] Brunton, St. Louis Congress of Arts and Sciences, 6, 176, 1904.

[4] "Chemical Pathology," 2, 1902.

[5] St. Louis Congress of Arts and Sciences, 6, 174, 1904.

[6] Brunton, St. Louis Congress of Arts and Sciences, 6, 177, 1904.

[7] Cf. Le Dantec, "La Stabilité de la Vie," 25, 1910.

serious mistakes. Thus plants and trees often flower at an abnormal time after receiving serious injury.[8] This is really one form of tendency to eliminate the disturbing factor. One should also distinguish between the direct injury to the plant or animal and the change in the organism which enables it or its descendants to withstand the disturbing influences.

A great deal has been done in the way of collecting facts illustrating the effect of environment on plants and animals: but the real reason for any particular change is rarely given,[9] and the change is only too often the resultant of two or more factors which are not differentiated carefully. I am going to cite some cases in which the application of the theorem of Le Chatelier is quite clear, and also others which seem interesting enough to warrant attention being called to them.

PRESSURE AND CONCENTRATION

The wind blows against the trees and the boughs bend so as to spill the wind. A prevailing wind from a given direction causes the trees to assume a permanent set. This is not especially interesting because this change is probably not inherited to any appreciable extent.

Bailey[10] has pointed out that plants tend to become circular instead of bilateral, because they are sessile.

They therefore found it to their advantage to reach out in every direction from their support in the search for food. Whilst the centrifugal arrangement has strongly tended to disappear in the animal creation, it has tended with equal strength to persist and to augment itself in the plant creation. Its marked development amongst plants began with the acquirement of terrestrial life, and with the consequent evolution of the asexual or sporophytic type of vegetation. Normally, the higher type of plant bears its parts more or less equally upon all sides, and the limit to growth is still determined by the immediate environment of the given individual or of its recent ancestors. Its evolution has been acephalic, diffuse or headless, and the individual plant or tree has no proper concentration of parts. For the most part it is filled with unspecialized plasma, which, when removed from the parent individual (as in cuttings or grafts), is able to reproduce another like individual. The arrangements of leaves, branches, the parts of the flower, and even of the seeds in the fruit, are thus rotate or circular, and in the highest type of plants the annual increments of growth are disposed in like fashion; and it is significant to observe that in the compositæ, which is considered to be the latest and highest type of plant-form, the rotate or centrifugal arrangement is most emphatically developed. The circular arrangement of parts is the typical one for higher plants, and any departure from this form is a specialization, and demands explanation.

In England rabbits are held in check, though with some difficulty. If the repressive factors are removed, as in Australia, the rabbits adapt themselves to the situation and multiply so as to become a veritable pest. In the same way the Russian thistle spread through the northwest some years ago. An insect will often adapt itself to changed conditions to such an extent as to take on new habits.[11]

An early naturalist traveling in Colorado found a striped beetle feeding upon wild solanums or nightshades. The insect came to be in demand among collectors, and it is said that handsome prices were paid for specimens for museums. In the course of time the settlers grew potatoes in Colorado and the insect took a fancy to them and spread rapidly. It is now known as the Colorado potato-beetle. The first attacks were noticed about thirty years ago, but now the insect is a serious pest wherever potatoes are grown in quantity.

[8] Möbius, "Lehre von der Fortpflanzung der Gewächse," 6, 122, 1897.

[9] Cf. Bailey, "The Survival of the Unlike," 32, 1896; MacDougal, *Memoirs N. Y. Bot. Garden*, 2, 1, 1903; Crozier, "The Modification of Plants by Climate," 1885; Eimer, "Organic Evolution," 1890.

[10] "The Survival of the Unlike," 15, 1896.

[11] Cf. Bailey, "The Survival of the Unlike," 184, 1896.

The displacement of equilibrium due to cultivating large areas to one crop has led to an enormous increase in the number of insects and fungous enemies in any given region.[12]

The excessive ravages of insects in the United States are largely owing to the cultivation of their food-plants in extended areas. Two hundred years ago not even the wild crab, the earliest representative of the apple, existed in this country, and consequently there were no apple insects. Later when a few apple trees became the adjunct of the simple homes of the early settlers, those of our insects to which they offered more desirable food than that on which they had previously subsisted were obliged to wing their way often for many miles in search of a tree on which to deposit their eggs. If birds were then abundant, how few of the insects could accomplish such extended flights! But in the apple orchards of the present day—some of them spreading in almost unbroken mass of foliage over hundreds of acres—our numerous apple insects may find the thrifty root, the vigorous trunk, the succulent twig, the tender bud, the juicy leaf, the fragrant blossom, and the crisp fruit spread out before them in broad array, as if it were a special offering to insect voracity, or a banquet purposely extending an irresistible invitation. . . . Careful cultivation has made it the best of its kind; appetite is stimulated; development is hastened; broods are increased in number; individuals are multiplied beyond the conservation of parasitic destruction; facilities of distribution are afforded with hardly a proper exercise of locomotive organs; and when these almost useless members have become absorbed, as in the wingless females of the bark-louse and the canker-worms, the interlocking branches afford convenient passage from tree to tree.

As Bailey[13] says:

We, as horticulturists, are every year planting new invitations to insect and fungous attacks. If we take this extra risk, we must certainly prepare ourselves to meet it. Our fathers' weapons can not avail against the horde of invaders which we are inviting to our doors. They are coming up out of the woods and the swamps and the bare fields to regale themselves at the banquet which we have spread.

Cultivation affords places of less struggle than organisms are forced to occupy under normal conditions. Man disturbs the equilibrium or removes the pressure in some direction, and a multitude is waiting to spring into the void. The great potato fields not only provided food, but there were few other insects to dispute the possession of them; the Colorado solanum beetle saw his opportunity, and improved it. He has been a successful bug. This release of the natural tension, which cultivation affords, is to my mind the most potent factor in the increase of our little foes.

TEMPERATURE

One effect of a lower temperature is obviously to produce a better protective coating on animals, while a higher temperature acts in the opposite way. I quote a few special cases from Darwin.[14]

According to Roulin, the semi-feral pigs in the hot valleys of New Granada are very scantily clothed; whereas, on the Paramos, at the height of 7,000 to 8,000 feet, they acquire a thick covering of wool lying under the bristles, like that on the truly wild pigs of France.

Roulin asserts that the hides of the feral cattle on the hot Llanos are always much less heavy than those of the cattle raised on the high platform of Bogota; and that these hides yield in weight and in thickness of hair to those of the cattle which have run wild on the lofty Paramos. The same difference has been observed in the hides of cattle reared on the bleak Falkland Islands and on the temperate Pampas.

Great heat seems to act directly on the fleece: several accounts have been published of the change which sheep imported from Europe undergo in the West Indies. Dr. Nicholoson, of Antigua, informs me that, after the third generation, the wool disappears from the whole body, except over the loins; and the animal then appears like a goat with a dirty door-mat on its back. A similar change is said to take place on the west coast of Africa. On the other hand, many wool-bearing sheep live on the hot plains of India. Roulin asserts that in the lower and heated valleys of the Cordillera, if the lambs are sheared as soon as the wool has grown to a certain thickness, all goes

[12] Lintner, First Report State Entom. N. Y., 10, 1882.

[13] "The Survival of the Unlike," 187, 1898.

[14] "Animals and Plants under Domestication," 2d ed., 1, 81, 95, 102, 1890.

on afterwards as usual; but if not sheared, the wool detaches in flakes, and short shining hair like that of a goat is produced afterwards. This curious result seems merely to be an exaggerated tendency natural to the Merino breed, for as a great authority, namely, Lord Somerville, remarks, "the wool of our Merino sheep after shear time is hard and coarse to such a degree as to render it almost impossible to suppose that the same animal could bear wool so opposite in quality, compared to that which has been clipped from it; as the cold weather advances, the fleeces recover their soft quality." As in sheep of all breeds the fleece naturally consists of longer and coarser hair, covering shorter and softer wool, the change which it often undergoes in hot climates is probably merely a case of unequal development; for even with those sheep which like goats are covered with hair, a small quantity of underlying wool may always be found. In the wild mountain sheep (*Ovis mountana*) of North America there is an analogous change of coat;[15] the wool begins to drop out in early spring, leaving in its place a coat of pelage quite different in character from the ordinary thickening—for instance, in the horse, the cow, etc., which shed their winter coat in the spring.

The fact of there being wool-bearing sheep in the hot plains of India is not necessarily a contradiction of the general law, because the tendency to change may be counteracted by careful selection.[16]

M. Lasterye, after discussing this subject, sums up as follows: "The preservation of the Merino race in its utmost purity at the Cape of Good Hope, in the marshes of Holland, and under the rigorous climate of Sweden, furnishes an additional support of this my principle, that fine-wooled sheep may be kept wherever industrious men and intelligent breeders exist.

If we remove a plant to a climate where frosts occur earlier, the chances are very good that the plant will be killed before the seeds ripen. If the variety is to survive, an early-ripening form must develop. This actually happens with wheat.[17]

[15] Audubon and Bachman, "The Quadrupeds of North America," 5, 365, 1846.

[16] Darwin, "Animals and Plants under Domestication," 2d ed., 1, 103, 1890.

[17] Darwin, "Animals and Plants under Domestication," 2d ed., 1, 333, 1890.

Wheat quickly assumes new habits of life. The summer and winter kinds were classed by Linnæus as distinct species; but M. Monnier has proved that the difference between them is only temporary. He sowed winter wheat in the spring, and out of one hundred plants four alone produced ripe seeds; these were sown and resown, and in three years plants were reared which ripened all their seed. Conversely, nearly all plants raised from summer wheat, which was sown in autumn, perished from frost; but a few were saved and produced seed, and in three years this summer variety was converted into a winter variety. Hence it is not surprising that wheat soon becomes to a certain extent acclimatized, and that seed brought from distant countries and sown in Europe, vegetates at first or even for a considerable period, differently from our European varieties. In Canada the first settlers, according to Kalm, found their winters too severe for winter wheat brought from France, and their summers often too short for summer wheat; and they thought that their country was useless for corn crops until they procured summer wheat from the northern part of Europe, which succeeded well.

Another interesting case is that of corn, also cited by Darwin.[18]

The tall kinds grown in southern latitudes, and therefore exposed to great heat, require from six to seven months to ripen their seed; whereas the dwarf kinds, grown in northern and colder climates, require only from three to four months. Peter Kalm, who particularly attended to this plant, says, that in the United States in proceeding from south to north, the plants steadily diminish in bulk. Seeds brought from lat. 37° in Virginia, and sown in lat. 43°–44° in New England, produce plants which will not ripen their seed, or ripen them with utmost difficulty. So it is with seed carried from New England to lat. 45°–47° in Canada. By taking great care at first, the southern kinds after some years' culture ripened their seed perfectly in their northern homes, so that this is an analogous case with that of the conversion of summer into winter wheat, and conversely. When tall and dwarf maize are planted together, the dwarf kinds are in full flower before the others have produced a single flower, and in Pennsylvania they ripen their seeds six weeks earlier than the tall maize. Metzger also mentions a European maize which

[18] "Animals and Plants under Domestication," 2d ed., 1, 341, 1890.

ripens its seed four weeks earlier than another European kind. With these facts so plainly showing inherited acclimatization, we may readily believe Kalm, who states that in North America maize and some other plants have gradually been cultivated further and further northward.

The peach tree offers another good instance of acclimatization.[19]

Mr. Crozier records testimony to the effect that peach trees in Michigan were injured no more at a temperature of twenty degrees below zero than they were in central Mississippi at a temperature of zero. Peach buds are injured at a much higher temperature at the south than at the north. Mr. P. H. Mell, Jr., director of the Alabama Polytechnic Institute at Auburn, writes me that buds are often killed even at a temperature of 34 to 38 degrees above zero. This observation undoubtedly refers to the partially expanded buds, yet it is well known that at the north a considerable frost is required to kill the swelling buds. It is possible that all these instances of the peach should fall under the division of adaptation through modification of individual constitution; but as I can not be certain, if indeed it is probable, that all these cases represent bud offspring, I place the statement here. If trees of the same variety show this difference in different latitudes, as they undoubtedly often do, then we have indisputable evidence of the acclimatizing of the individual.

Bailey's quotation from Cooper as to watermelons also has a bearing on this matter.[20]

A striking instance of plants being naturalized happened by Colonel Matlack sending some watermelon seed from Georgia, which, he informed me [Cooper] by letter, were of superior quality. Knowing that seed from vegetables which had grown in more southern climates required a longer summer than what grew here, I gave them the most favorable situation, and used glasses to bring them forward, yet very few ripened to perfection; but finding them to be so excellent in quality as described, I saved seed from those first ripe; and by continuing that practise four or five years, they became as early watermelons as I ever had.

[19] Bailey, "The Survival of the Unlike," 325, 1896.

[20] Bailey, "The Survival of the Unlike," 154, 1896.

Changes in the colors of some butterflies can be obtained by varying the temperature during the pupal stage of development. While we are not able to prove that these changes are beneficial adaptations, it is interesting to note that these changes characterize the same butterflies in arctic and tropic regions.[21]

Warmth acting on pupæ of *V. Cardui* (painted lady), gave an extraordinarily pale form, like those found in very different parts of the tropics. Cold, on the other hand, gave specimens with a very recognizable darkening of the whole insect, such as is exhibited by a form found in Lapland.

We have no clue[22] at all as to the influence a low temperature has upon the production of wings in aphides. "As long as the temperature is high and the moisture sufficient, plant lice are wingless, but if the temperature be lowered, wings begin to grow." The problem is an interesting one and should not be difficult to solve with the aid of the theorem of Le Chatelier.

LIGHT

Since light tends to destroy any substance which absorbs it, it seems at first sight as though transparent, colorless plants and animals would be the surviving type in the intense light of the tropics. Light does tend to bleach organic colors; but the flaw in the reasoning is that we are dealing with living organisms.[23] It is easier for a man or an animal to develop a pigmented coating and thus eliminate the chemical action of light on blood[24] than for it to acquire the habit of living without red corpuscles. It is evidently better for a plant to develop chlorophyll and a healthy

[21] Vernon, "Variations in Plants and Animals," 237, 1903.

[22] Loeb, "The Dynamics of Living Matter," 112, 1906.

[23] Cf. Eimer, "Organic Evolution," 136, 1890.

[24] Cf. Woodruff, "Effects of Tropical Light on White Men," 10, 85, 1905.

appetite for carbon dioxide than for it to be bleached by the light.

Consequently we find that man is invariably covered with a pigment which acts as an armor to exclude the more harmful short rays, and moreover the amount of pigment is in direct proportion to the intensity of the light of the country to which his ancestors have proved their adjustment by centuries or millenniums of survival in health and vigor. It is a simple matter of mathematics to show that the intensity of light under the zenith sun in the tropics is the greatest, and that the amount of rays per unit of surface diminishes as we go north in proportion to a function of the latitude. In addition to this, the further from the tropics we go the greater is the layer of air which the rays must pass through and the more of them which are absorbed. Hence we can reach a latitude where there is insufficient light for plant growth even if there could be sufficient warmth. Yet man flourishes in these regions, and so do other animals. Hence we find the greatest pigment in the tropics among the Australians, New Guineas, Negritos, East Indians and African Negroes, some of whom are nearly jet black. As we go north from the tropics we find the complexions gradually lightening, being dark brown in Egypt, light brown in north Africa states, deep olive in the Mediterranean, olive in southern Europe, brunette in central Europe and blond in the northwestern sections of Europe, embraced by a curve passing through northern France, northern Germany and northwest Russia.

Undoubtedly the negro, while in the shade, is able to radiate heat better than whites, and this enables him to keep cool in the tropics, but puts him at a disadvantage in the north where the white man can keep warmer with less clothing and less fire in the house. But it is a secondary cause enhancing the first, because when it comes to a question of light and cold, nature makes no mistakes, but selects a color able to exclude the light. Hence in all cold, light countries, *i. e.*, steppes, plains, and the arctics, there is a pigmentation of a color in the lower end of the spectrum, red or yellow, with variations of brown, olive or copper. As a rule the color is markedly light yellow in cold, light countries, as in North China.

In America we had every shade from the blackest Indians of tropical South America through all the shades of copper and brown to the very light, almost white Indians of the northeastern part of the United States, who had conditions very similar to those suited for the blonds of Europe. In Italy, Spain and China, we find the same thing, for the men of the south are markedly darker than those of the north.

The same law holds in France, Germany, Russia, Persia and India: the north is decidedly blonder than the south, and the same is found in the British Islands, but in a much modified way. Even the Ainos in the north of Japan are said to be lighter than the Japanese.

All these red and yellow colors undoubtedly enable the native to conserve his heat almost as well as the white man, and at the same time exclude the dangerous short waves.

In Africa, Eimer[25] found that in passing up the Nile valley from the Delta to the Soudan, the natives gradually became more and more dark-skinned the further south they lived.

Woodruff[26] recommends that white men in the tropics should wear white outer garments and black underclothes, which constitutes a pretty fair imitation of a dark-skinned Arab in a white burnous.

Vernon[27] points out "that the diminution or disappearance of pigmentation following upon withdrawal of light, is best illustrated by reference to the well-known cave animals. Of these, one of the most interesting is *Proteus anguineus,* which is found in the subterranean caves of the Karst Mountains about Adelsberg. This amphibian is almost white, but if kept for some time in the light, it gradually becomes pigmented. Pigment cells are, in fact, still present in its skin, and in all probability these are directly stimulated to exert their function by the action of the light." If Vernon had been familiar with the theorem of Le Chatelier, he would have worded this last sentence very differently.

In the case of heliotropism, the animals

[25] "Organic Evolution," 88, 1810.

[26] "Effects of Tropical Light on White Men," 321, 1905.

[27] "Variation in Animals and Plants," 250, 1903.

turn automatically to or from the source of light, depending on whether they are positively or negatively heliotropic. In some cases they also move automatically towards or away from the light. Loeb[28] says in regard to this:

> This automatic orientation is determined by two factors, first a peculiar photo-sensitiveness of the retina (or skin), and second a peculiar nervous connection between the retina and the muscular apparatus. In symmetrically built heliotropic animals in which the symmetrical muscles participate equally in locomotion, the symmetrical muscles work with equal energy as long as the photo-chemical processes in both eyes are identical. If, however, one eye is struck by stronger light than the other, the symmetrical muscles will work unequally and in positively heliotropic animals those muscles will work with greater energy which bring the plane of symmetry back into the direction of the rays of light and the head towards the source. As soon as both eyes are struck by the rays of light at the same angle, there is no more reason for the animal to deviate from this direction and it will move in a straight line. All this holds good on the supposition that the animals are exposed to only one source of light and are very sensitive to light.

Loeb[29] has also shown that the heliotropism may sometimes be modified or even reversed by adding certain chemicals to the water. He has also shown[30] that some animals seek automatically the places where the intensity of light is a minimum; but that this is not negative heliotropism because the animals do not necessarly move along the path of the ray. In all these cases we have an application of our law, because the animals arrange themselves so as to minimize the state of stress.

It had always seemed to me a most mysterious thing that animals should be heliotropic, until it finally dawned on me that we are all of us heliotropic to a certain extent. Place a man out in an intense light and, if he can not shade his eyes, it will take a pretty strong special stimulus to keep him from turning his back to the light. If his eyes happen to be weak, he will respond more promptly and more automatically to the light. He is negatively heliotropic to strong light. I am inclined to think that man is positively heliotropic to a faint light, because he would certainly tend to turn towards the point that he could see. We can also find an analogy to the case of the animals which congregated at the places where the intensity of light is a minimum. Place a man out on the desert in blazing sunlight and it will take a strong counter-stimulus to keep him from moving into any shade that he can find. Here the irritation is due to heat and not to light; but the man is not negatively thermotropic because he will move across the temperature gradient in order to reach the shade.

Of course the reflex action is not relatively so powerful with man as with the lower animals. In fact, Loeb[31] says that "it rarely happens that animals endowed with the mechanisms of associated memory react in such a machine-like manner to the elementary forces of nature as the heliotropic animals which we have discussed."

Vernon[32] points out that

> If plants be allowed to grow in absolute darkness, they, as a rule, become very much elongated in form whilst their leaves are small and ill shaped. . . . Sachs found that potato tubers grown in darkness for fifty-three days produced sprouts from 150 to 200 mm. high, whilst similar ones grown in daylight were only 10 to 13 mm. high. Again he found that the hypocotyl of the buckwheat (*Fagopyrum*) reached a height of 35 to 40 cm. in the dark, whilst it grew only to 2 or 3 cm. when freely exposed to light. K. Goebel

[28] "Darwin and Modern Science," 264, 1909.

[29] "The Dynamics of Living Matter," 131, 1906; "Darwin and Modern Science," 265, 1909.

[30] Loeb, "The Dynamics of Living Matter," 136, 1906.

[31] "The Dynamics of Living Matter," 135, 1906.

[32] "Variation in Animals and Plants," 245, 1903.

has shown that if cactuses are cultivated in darkness, their form changes completely. The young shoots are rounded, and fail to show the angular irregularities of form which increase the surface capable of effecting assimilation under the influence of light.

Since the leaves especially are effective in the light, the absence of light will prevent normal development of the leaves and this seems to be the chief direct effect. If the plant does not have to develop leaves to any extent, there is more food available for the stem; and the growth of the stem is thus really a secondary effect. The matter is still further complicated by the fact that the moisture content and the carbon dioxide content of the air were not kept constant during the two sets of experiments.

An increase in the intensity of the light is often accompanied by a decrease in the surface of the leaf and an increase in the thickness.[33] I think that it is a mistake to attribute this change to the action of light alone. It is more the combined effect of light and dryness, or of light and the higher rate of evaporation due to a higher temperature. With decreased surface and greater thickness there is less evaporation, one extreme of which is reached in the eucalyptus with its leaves turned edgewise. The assimilation of food is provided for by an increased thickness of the chlorophyll layer, because the more intense light can penetrate farther into the leaf.

We have seen that the pigment in the negro's skin is essentially protective in action. A thicker or coarser leaf may also be a protection against too intense a light. Rowlee[34] found that "intense light does not kill thick, coriaceous or succulent leaves with heavy cutinized external walls . . . doubtless owing to the screening effect of the heavy walls or cells containing much water."

We have not sufficient data to make it possible to say why an increase in the intensity of light causes the change from sexual to asexual reproduction in some algæ and the reverse change in others;[35] but we can be quite certain that both changes are in conformity with the theorem of Le Chatelier.

MOISTURE

Vernon[36] says that "the effect of a dry soil and atmosphere is well shown by the characters of desert plants. These are stunted in growth, and are of a nearly uniform gray color, owing to their intense hairiness. The leaves are more fleshy, and there is a great tendency to the formation of spines. That these characters are in part at least the direct result of want of water is shown by the fact that they may disappear if water is supplied." The development of hairs is of great advantage to a plant in an arid climate, especially if there is any wind. The circulation of air, and consequently the rate of evaporation is impeded by the mass of hairs.

We get characteristic changes when plants, normally terrestrial, are grown in water.[37]

As regards the leaves, it is well known that when aerial and floating leaves are present on the same aquatic plant, they differ greatly in structure, and as a rule also in form, from the submerged leaves. In *Ranunculus heterophyllus* and *Cabomba aquatica*, for instance, the floating leaves are more or less rounded, whilst the submerged ones have dissected and filiform segments. In *Hippuris* (mare's tail) the aerial and floating leaves are short, and in *Callitriche* rounded, but

[33] Vernon, "Variation in Animals and Plants," 248, 1903.

[34] Proc. 19th Meeting Soc. Promotion Agric. Science, Boston, 1898.

[35] Loeb, "Darwin and Modern Science," 230, 1909.

[36] "Variation in Animals and Plants," 263, 1903.

[37] Cf. Vernon, "Variation in Animals and Plants," 266, 1903.

the submerged leaves of both are linear or ribbon-like. In all cases the submerged leaves are of a more delicate texture, more or less translucent, and of a brighter green color than the others.

This is a much more complex case than Vernon realizes. Submerged leaves do not develop the supporting frame of the aerial leaves. The delicate texture is therefore to a great extent a result of the supporting power of the water and not of its wetness. Since the supporting structure of the aerial leaf is not developed when the leaf is submerged, the leaf grows longer, just as the stem of the plant grows longer in the dark because the leaves develop but slightly. The thinness of the leaf is probably chiefly a result of the decreased intensity of light. This is the best analysis that can be given at present; but it brings out clearly how slack people have been in controlling conditions.

The effect of excessive moisture or aridity upon plants is similar in type[38] to the effect of heat or cold on the pupæ of butterflies.

The relation of leaf form to environment has often been investigated and is well known. The leaves of bogs and water-plants afford the most striking examples of modifications: according as they are grown in water, moist or dry air, the form of the species characteristic of the particular habitat is produced, since the stems are also modified. To the same group of phenomena belongs the modification of the forms of leaves and stems in plants or transplantation from the plains to the mountains or *vice versa*. Such variations are by no means isolated examples. All plants exhibit a definite alteration in form as the result of prolonged cultivation in moist or dry air, in strong or feeble light or in darkness, or in salt solutions of different composition and strength.

The last sentence in the preceding paragraph is interesting for what it does not say. There is no indication that Klebs has any inkling of the universal law underlying all these changes.

[38] Klebs, "Darwin and Modern Science," 235, 1909.

FOOD AND FERTILIZERS

It seems evident that an exuberant growth would be favorable to variability and to the development of sports. This is universally recognized to be the case. Thus Darwin[39] says:

Of all the causes which induce variability, excess of food, whether or not changed in nature, is probably the most powerful. This view was held with regard to plants by Andrew Knight and is now held by Schleiden, more especially in reference to the inorganic elements of the food. In order to give a plant more food, it suffices in most cases to grow it separately, and thus prevent other plants robbing its roots. It is surprising, as I have often seen, how vigorously our common wild species flourish when planted by themselves, though not in highly manured land; separate growth is, in fact, the first step in cultivation, we see the converse of the belief that excess of food induces variability in the following statement by a great raiser of seeds of all kinds: "It is a rule invariably with us, when we desire to keep a true stock of any one kind of seed, to grow it on poor land without dung; but when we grow for quantity we act contrary, and sometimes have dearly to repent of it." According also to Carrière, who had great experience with flower-garden seeds, "On remarque en général les plantes de vigeur moyenne sont celles qui conservent le mieux leurs caractères."

Under the heading of effect of cultivation, Klebs[40] says:

It is however a fact that if a plant is removed from natural conditions into cultivation, a well-marked variation occurs. The well-known plant breeder, L. de Vilmorin, speaking from his own experience, states that a plant is induced to *affoler*, that is, to exhibit all possible variations from which the breeder may make a further selection only after cultivation for several generations. The effect of cultivation was particularly striking in *Veronica chamædrys*, which, in spite of its wide distribution in nature, varies very little. After a few years of cultivation this "good" and constant species becomes highly variable. The specimens on which the experiments were made were three modified inflorescence cuttings, the

[39] "Animals and Plants under Domestication," 2d ed., 2, 214, 1890.

[40] "Darwin and Modern Science," 245, 1909.

parent plants of which certainly exhibited no striking abnormalities. In a short time many hitherto latent potentialities became apparent, so that characters, never previously observed, or at least very rarely, were exhibited, such as scattered leaf arrangements, torsion, terminal or branched inflorescences, the conversion of the inflorescence into foliage-shoots, every conceivable alteration in the color of flowers, the proliferation of flowers.

One more quotation will suffice, this time from Bailey.[41]

Now let us endeavor to put ourselves in nature's place, if such a conception is possible, and to briefly follow an outline of her methods with plants. We shall find that variation is largely the result, so far as we can see, of excess of food supply. The seedsman knows that heavy lands make his seed-crops break into non-typical forms, and he therefore prefers, for most plants, a soil not very rich in nitrogen or growth production. Heavy soils make the dwarf peas "viney," and bud sprouts of curious leaves and flowers are wont to appear upon over vigorous shoots.

Since conditions which tend to shorten the life of a plant or tree often cause the plant or tree to flower,[42] it follows that conditions which favor a rank growth are likely to be disadvantageous to the production of flowers. This is actually the case.[43]

One extreme case, that of exceptionally early flowering, has been observed in nature and more often in cultivation. A number of plants under certain conditions are able to flower soon after germination. This shortening of the period of development is exhibited in the most striking form in trees, as in the oak,[44] flowering seedlings of which have been observed from one to three years old, whereas normally the tree does not flower until it is sixty or eighty years old.

Another extreme case is represented by prolonged vegetative growth leading to the complete suppression of flower-production. The result may be obtained with several plants, such as *Glechoma*, the sugar beet, *Digitalis*, and others, if they are kept during the winter in a warm, damp atmosphere, and in rich soil; in the following spring or summer they fail to flower. Theoretically, however, experiments are of greater importance in which the production of flowers is inhibited by very favorable conditions of nutrition occurring at the normal flowering period. Even in the case of plants of *Sempervivum* several years old, which, as is shown by control experiments on precisely similar plants, are on the point of flowering, flowering is rendered impossible if they are forced to very vigorous growth by an abundant supply of water and salts in the springs. Flowering, however, occurs, if such plants are cultivated in relatively dry soil and in the presence of strong light. Careful researches into the conditions of growth have led, in the case of *Sempervivum*, to the following results: (1) With a strong light and vigorous carbon assimilation in strong light, a considerably increased supply of water and nutritive salts produces active vegetative growth. (2) With vigorous carbon assimilation in strong light, and a decrease in the supply of water and salts, active flower production is induced. (3) If an average supply of water and salts is given, both processes are possible; the intensity of carbon assimilation determines which of the two is manifested. A diminution in the production of organic substances, particularly of carbohydrates, induces vegetative growth. This can be effected by culture in feeble light or in light deprived of the yellow-red ray: on the other hand, flower-production follows increase in light intensity. These results are essentially in agreement with well-known observations on cultivated plants, according to which, the application of much moisture, after a plentiful supply of manure composed of inorganic salts, hinders the flower-production of many vegetables, while a decrease in the supply of water and salts favors flowering.

Good manuring is in the highest degree favorable to vegetative growth, but is in no way equally favorable to the formation of flowers. The constantly repeated expression, good or favorable nourishment, is not only vague but misleading, because circumstances favorable to growth differ from those which promote reproduction; for the production of every form there are certain favorable conditions of nourishment, which may be defined for each species. Experience shows

[41] "The Survival of the Unlike," 169, 1898.

[42] Möbius, "Beiträge zur Lehre von der Fortpflanzung der Gewächse," 7, 125, 1897.

[43] Klebs, "Darwin and Modern Science," 232, 246, 1909.

[44] Möbius, "Beiträge zur Lehre von der Fortpflanzung der Gewächse," 89, 1897. [The conditions are not given by Möbius.—W. D. B.]

that, within definite and often very wide limits, it does not depend on the *absolute amount* of the various food substances, but upon their respective degrees of concentration. As we have already stated, the production of flowers follows a relative increase in the amount of carbohydrates formed in the presence of light, as compared with the inorganic salts on which the formation of albuminous substances depends.[45] The various modifications of flowers are due to the fact that a relatively too strong solution of salts is supplied to the rudiments of these organs. As a general rule every plant form depends upon a certain relation between different chemical substances in the cells and is modified by an alteration of that relation.

Vernon[46] cites some interesting cases in which changes of diet have apparently produced results in accordance with our law.

John Hunter observed a most marked thickening and hardening in the stomach of a gull (*Larus tridactylus*) which had been fed for a year on grain. It is stated by Dr. Edmonston that a similar change takes place under natural conditions every year in the stomach of the common herring gull (*Larus argentatus*). Thus in the Shetland Islands this bird feeds in the winter on fish, but in the summer frequents the cornfields and feeds on grain. Dr. Edmondston has also noticed a somewhat similar change in the stomach of a raven which had been fed for a long time on vegetable food. Again, Menetries found that in an owl (*Strix Gallaria*) the effect of vegetable diet was to change the form of the stomach and make the inner coat leathery.

The converse experiment of feeding graminivorous birds on a flesh diet has been made by Dr. Holmgren. By feeding pigeons on meat for a considerable time, he found that the gizzard gradually acquired the qualities of a carnivorous stomach. Again Delage fed a fowl for three years on meat, and found that the muscular substance of its gizzard was considerably decreased. All these results, though apparently so unequivocal, have not passed unchallenged; for G. Brandes,[47] who fed both flesh-feeding birds on grain, and grain feeders on flesh, states that he was unable to trace any adaptation to the altered conditions in either case.

[45] Klebs, "Künstliche Metamorphosen," 117.

[46] "Variation in Animals and Plants," 295, 1903.

[47] *Biol. Centralblatt*, 16, 825.

Since these alleged changes are directly in line with the cases previously quoted, of the changes in butterflies and bog plants, it seems probable that the negative results are due to error. It is very desirable, however, that this point should be settled definitely one way or the other.

A very complicated case of the effect of the environment, and one which I shall not attempt to account for, is cited by Poulton.[48]

Entirely new light upon the seasonal appearance of epigamic characters is shed by the recent researches of C. W. Beebe,[49] who caused the scarlet tanager (*Piranga erythromelas*) and the bobolink (*Dolichonyx oryzivorus*) to retain their breeding plumage through the whole year by means of fattening food, dim illumination and reduced activity. Gradual restoration to the light and the addition of meal-worms to the diet invariably brought back the spring song, even in the middle of winter. A sudden alteration of temperature, either higher or lower, caused the birds nearly to stop feeding, and one tanager lost weight rapidly and in two weeks moulted into the olive-green winter plumage. After a year, and at the beginning of the normal breeding season, "individual tanagers and bobolinks were gradually brought under normal conditions and activities"; and in every case moulted from nuptial plumage to nuptial plumage. "The dull colors of the winter season had been skipped." The author justly claims to have established "that the sequence of plumage in these birds is not in any way predestined through inheritance . . .," but it may be interrupted by certain factors in the environmental complex.

SECRETIONS

Under physiology and medicine mention has previously been made that many organisms give rise to products which are toxic to the organism and which must be removed. Brunton[50] points out that "an excessive quantity of their own products is usually injurious to cells and too much alcohol will stop the growth of yeast. At

[48] "Darwin and Modern Science," 297, 1909.

[49] *The American Naturalist*, 42, 34, 1908.

[50] "Darwin and Modern Science," 174, 1909.

the same time these products are frequently very nutritious for cells of a different sort and alcohol furnishes a most suitable pabulum for the organisms which produce vinegar. Vinegar in its turn is toxic to the microbe which produces it, but serves again as a soil for another which gives rise to a viscous fermentation. By the successive action of these ferments a solution of sugar may produce, first, alcohol, secondly, vinegar, and thirdly, ropy mucus. In this particular series each microbe produces a substance injurious to itself but useful to its successor. This is, however, not always the case because a cell may produce a substance not only injurious to itself but injurious to other cells, and alcohol in large quantity not only kills the cells of yeasts, but other cells as well. Similar conditions occur within living organisms where the cells composing the different parts are connected together and pass on the products of their life from one cell to another by means of the circulation of the blood and tissue juices. The secretions of one part may be, and indeed generally are, useful to other parts of the organism and so long as no part sins, either by deficiency or excessive action, the whole organism maintains a condition of health. But this is not always the case and health may be destroyed by (*a*) excessive, (*b*) defective or (*c*) prevented action of one or more of the parts composing the body."

Vernon[51] has tested the influence of the excreta of adult echinoids upon larval growth.

Echinoids of known weight were kept for a known time in a known volume of water, so that, on determining the absolute effect produced on larvæ grown in this water it was possible to calculate the relative effect produced by unit weight of echinoids kept for unit time in unit volume of water. On growing larvæ in water previously fouled by adult echinoids of their own species, it was found that, as a mean of five observations, they were diminished in relative size by 2.6 per cent., whilst only 41 per cent. of the ova employed reached the larval stage. On growing them in water fouled by echinoids of other than their own species, the larvæ, as a mean of five observations, were diminished by only 1.9 per cent., whilst 54 per cent. of the ova reached the larval stage. That is to say, the products of excretion of an echinoid act more adversely both on the death rate and on the growth of embryos if these belong to its own species than if they belonged to another species. At least this is the case with *Strongylocentrotus*, *Sphærechinus* and *Echinus*. With two other (physiologically) less closely related species, viz., *Arbacia pustulosa* and *Dorocidaris papillata*, it was even found that the products of excretion, so far from acting adversely on growth, actually favored it. Thus *Strongylocentrotus* larvæ grown in water fouled by these two species were increased in size by respectively 4.3 and 1.7 per cent., whilst respectively 81 and 50 per cent. of the ova employed reached the pluteus stage.

Vernon[52] points out also that "De-Varigny actually found that snails grown in water in which other snails had already been growing several months were distinctly smaller than those grown in fresh water, and if the excreta of snails had been added as well they were smaller still."

The experiments of Warren[53] show that water fouled by *Daphnia* becomes specifically injurious to *Daphnia*, "for when the *Daphnia* are fast disappearing, there may be a swarm of ostracods or copepods (still living healthily in the water)."

If we were to reason from these facts to the behavior of crops, such as wheat, for instance, we should conclude that wheat unquestionably secretes substances which are toxic to itself and that the development of that crop or of a subsequent one

[51] "Variation in Animals and Plants," 298, 1903.

[52] "Variation in Animals and Plants," 305, 1903.

[53] Vernon, "Variation in Animals and Plants," 309, 1903.

would depend in part on the degree of the accumulation of the toxic substances in the soil. If the toxic substances were removed or destroyed sufficiently rapidly, no deleterious result would occur; but, otherwise, there would be one. We should also conclude that the secretions from the wheat would not necessarily be toxic to other crops. These *a priori* predictions seem to be confirmed by the facts.

Cameron[54] points out that

> It has been found that as a general rule the continued growth of one crop in any soil results in a low crop production. Pot cultures have given even more pronounced results in the same direction. The explanation long accepted is that the soil has, as a result of the continued cropping, become deficient in one or more of the "available" mineral nutrients. Pot experiments, where the garnered crop was returned to the soil and still diminished yield was obtained, throw doubt on this explanation. Still further doubt results from water cultures which, by growing a crop in them, become "poor" for subsequent crops, although there is maintained in them an ample supply of mineral plant nutrients, and they are easily renovated by good adsorbers. These facts find a more satisfactory explanation as being due to the production in the nutrient medium of deleterious organic substances originating in the growing plant itself. This idea seems to have been advanced first by De Candolle, in 1832, to account for the beneficial results obtained by employing a rotation of crops. It appears to have been held by Liebig at one time, although he subsequently abandoned it in favor of the view that the benefits of a crop rotation are due to the several crops requiring different proportions of mineral nutrients, and that the disturbance of the balance in the soil produced by one crop is not unfavorable to the growth of some other crop. Although lacking direct experimental confirmation, this latter view of Liebig's has long prevailed among agricultural investigators, partly by reason of his authority, partly by reason of the dominance of the plant food theory of fertilizers, and partly by reason of the fact that the ideas of De Candolle, as originally advanced, include certain errors soon detected. The trend of recent investigations has been distinctly in favor of a modified form of the view of De Candolle. It has been recognized that other factors enter into crop rotations, such as the elimination of associated weeds, various kinds of animal, insect and plant parasites, preparation of the soil by a deep-rooted crop for a shallow-rooted following crop, etc. It has come to be recognized that there are natural associations of plants and natural rotations of vegetation certainly determined by other than plant-food factors. Thus, in the eastern United States, wheat is followed by ragweed naturally, while, across the fence cocklebur and wild sunflowers come in after the corn, the difference in vegetation being as sharply marked after the removal of the crops as when they still occupied the land. Analyses of the ragweed, for instance, altnough it is a shallower rooted crop than wheat, show that it takes from the soil as much of the mineral nutrients as does the preceding wheat crop. The investigation of Lawes and Gilbert on fairy rings showed that the continual widening of the rings can not be satisfactorily explained by the comparison of the mineral constituents in the soil within and without the rings. Work at Woburn on the effect of grass on apple trees finds no other plausible explanation than that the growing grass produces in the soil organic substances detrimental to young apple trees. A number of similar cases have been recorded.

[54] *Jour. Phys. Chem.*, 14, 425, 1910.

CLIMATE

When seeds are planted in a new locality, a great many conditions are varied simultaneously and it is difficult, usually impossible, to tell to what extent each factor causes the changes that actually take place or why any given change is beneficial. If we compare two varieties of the same plant, it seems reasonable to suppose, unless proof to the contrary is given, that the local variety is fairly well adapted to the local conditions, in which case one would expect the foreign variety to vary towards the local one. Darwin[55] cites a case of this sort.

> The effects of climate of Europe on the American varieties [of maize] is highly remarkable. Metzger obtained seed from various parts of

[55] "Animals and Plants under Domestication," 2d ed., 1, 340, 1890.

America, and cultivated several kinds in Germany. I will give an abstract of the changes observed in one case, namely, with a tall kind (*Breit-körniger Mais, Zea altissima*) brought from the warmer parts of America. During the first year the plants were twelve feet high, and a few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation the plants were from nine to ten feet in height, and ripened their seed better; the depression on the outer side of the seed had almost disappeared, and the original beautiful white color had become duskier. Some of the seeds had even become yellow, and in their now rounded form they approached common European maize. In the third generation nearly all resemblance to the original and very distinct American parent-form was lost. In the sixth generation this maize perfectly resembled a European variety, described as the second sub-variety of the fifth race. When Metzger published his book, this variety was still cultivated near Heidelberg, and could be distinguished from the common kind only by a somewhat more vigorous growth.

Bailey[56] draws the following conclusion in regard to American fruits and American climate:

American fruits constantly tend to diverge from the foreign types which were their parents, and they are, as a rule, better adapted to our environments than foreign varieties are. In less than a century we have departed widely from the imported varieties which gave us a start. At the expiration of another century we should stand upon a basis which is nearly if not wholly American.

Darwin[57] notes a similar case.

Mr. Meehan has compared twenty-nine kinds of American trees with their nearest European allies, all grown in close proximity and under as near as possible the same conditions. In the American species he finds, with the rarest exceptions, that the leaves fall earlier in the season and assume before their fall a brighter tint; that they are less deeply toothed or serrated; that the buds are smaller; that the trees are more diffuse in growth and have fewer branchlets; and lastly, that the seeds are smaller—all in comparison with the corresponding European species. Now considering that these corresponding trees belong to different orders, and that they are adapted to widely different stations, *it can hardly be supposed that their differences are of any special service to them in the new and old worlds;*[58] and, if so, such differences can not have been gained through natural selection, and must be attributed to the long continued action of a different climate.

As a matter of fact, most of these changes are just what would be beneficial in a country having a hot, dry, summer with a relatively long winter. If planted in a very moist place, the American elm develops some of the characteristics of the English elm.

Woodruff[59] has pointed out one marked case of adaptation to climate.

The shape and size of the nose and position of the nostrils are now fairly well proved to be a matter of selection of fittest variations. In the tropics where the air is hot and therefore rarefied, more of it is necessary and it is essential that there should be no impediment to the air currents, so that the nostrils are open and wide and the nose very flat. Such a nose is unsuited for cold countries, as it permits masses of cold air to flood the air passages and irritate the lining membrane, so that the nose must be large and have much warming surface, and the nostrils therefore are slender slits to admit the air in thin ribbons easily warmed. The air being cold is concentrated, and less of it is needed than in the tropics and the slender nostril is no disadvantage. The nasal index or extreme width of nose divided by the extreme length, gradually increases as we go to colder countries, where we find some races with nose index much greater than one thousand, *i. e.*, width greater than length. It is now many years since it was first pointed out that the open tropical nostril was one reason for so much pulmonary trouble of negroes out of tropics. Hence there must have been a natural selection in cold countries of one kind of variations—large concentrated noses, and a selection in hot countries

[56] "The Survival of the Unlike," 319, 1898.

[57] "Animals and Plants under Domestication," 2d ed., 2, 27, 1890.

[58] [The italics are mine.—W. D. B.]

[59] "Effects of Tropical Light on White Men," 4, 1905.

of the other extreme, so that the various types gradually arose.

The great Biblical Pharaoh Rameses II. had a prominent, slender nose not now found in any Egyptians, and it is a positive proof of the recent arrival of some ancestor from the north. He was like Lord Cromer—a northern type ruling a native type.

Allen[60] has called attention to a correlation between climate and the color of birds.

The increase in color towards the south coincides with the increase in the intensity of the sun's rays and in the humidity of the climate. The increase in color observed in birds on passing from east to west [in the United States] seems also to coincide with an increase of humidity, "the darker representatives of any species occurring where the annual rainfall is greatest, and the palest where it is least." This coincidence occurs not only in the birds of the United States to such a degree that Allen says he knows of no exception, but in Europe also. Thus birds from the Scandinavian coast are very much darker than in central Europe, where the rainfall is only half as great. Allen says that this correlation of brighter and deeper tint with increased humidity is exhibited by the mammals of these districts as well as by the birds.

NON-ADAPTABILITY

While the theorem of Le Chatelier enables us to account for the direction of a change, it does not tell us whether a given stimulus will actually produce a change or under what condition the change will be a maximum for the same stimulus. We can make a fair guess at the answer by studying ourselves. We know that, as we get older, our tendency to resist change increases; our habits of body and mind become more fixed. We should therefore be tempted to conclude that the resistance to change increases as the organism becomes mature and that a given stimulus would probably have the most effect if applied at or before the earliest stages of development. The following quotation from Vernon[61] would seem to indicate that this was often true.

Due reflection, will, I believe, incline one to infer that what is true for echinoid larvæ is true for most multicellular organisms. In fact, it would seem to be a law of general application that *the permanent effect of environment on the growth of a developing organism diminishes rapidly and regularly from the time of impregnation onwards.*

It is curious that this principle, enunciated by the author in 1900, should have been laid down by De Vries only a few months later, as the result of his observations on plants. Thus, judging from the effects of nutrition (manuring, planting out, good light and watering), he concluded that: (1) the younger a plant is, so much the greater is the influence of external conditions on its variability. (2) The nutrition of the seed, when developing on the maternal plant, has—at least very often—a greater influence on the variability than nutrition during its germination and later growth.

If the pressure on a liquid is made less than the vapor pressure for that liquid at that temperature, some of the liquid vaporizes, the temperature falls, and the liquid may be said to adapt itself to the new conditions. What would happen if the liquid were not adaptable? The easiest way to obtain a non-adaptable liquid is to place a Bunsen burner under it. The temperature rises until the boiling-point is reached. The liquid then ceases to be adaptable. It volatilizes, it disappears, it becomes extinct so far as that particular region or flask is concerned. If a species can not adapt itself to changed climate or other conditions, it does not volatilize; but it disappears, it becomes extinct. It may be a new point of view to consider the extinction of the mastodon as analogous to the distillation of water; but the two cases are really parallel, except in time.

It should be kept in mind that non-adaptability is not the only cause for ex-

[60] Vernon, "Variations in Plants and Animals," 327, 1903.

[61] "Variation in Animals and Plants," 199, 1903.

tinction. A species might have enormous potential adaptability; but it would become extinct if the death-rate were too high in comparison with the rate of adaption. This principle is made use of in the fight against weeds.[62]

Weeds, like other plants, grow where they can find room; and the more room any plant can find, other things being the same, the farther and more rapidly it will spread over the earth. But room, used in this connection, does not mean, entirely, space vacant of other plants, but rather conditions of competition into which the given plant can fit itself with prosperity. Ground may be covered with a given plant, and yet a species of wholly different character and habits may thrive along with it. This is well illustrated in the growth of twining or climbing vines in dense thickets of shrubbery, or the practise, common even with the Indians, of growing pumpkins in corn fields. If weeds, then, are to be kept out of grounds, the land must not only be occupied with some other crops, but with a crop which will not allow the weed to grow along with it. In practise, it is impossible to select all crops from plants which so completely encumber the ground that no intruder can find a foothold; but this disadvantage is readily and almost wholly overcome by means of the rotation of crops—one crop in the rotation destroying what weeds may have crept in with the preceding ones. Thorough cropping of the land and judicious rotation of crops, therefore, are conditions against which no weeds can stand; and as these are the vital conditions, also, of successful agriculture, it may be said that then lands are well farmed.

The daisy-cursed meadows of the east are those which have been long mown and are badly "run," or else those which were not properly made, and the grass obtained but a poor start. The farmer may say that the daisies have "run out" the grass, but the fact is that the meadow began to fail, and the daisies quickly seized upon the opportunity to gain a foothold; and just so long as the farmer persists in his accustomed methods will the daisies usurp the land. The weedy lawns are those which have a thin turf, and the best treatment is to scratch the ground lightly with an iron-toothed rake, apply fertilizer and sow more seed; in other words, augment the struggle for existence, and the weeds will go down before the June grass, and the grass plants themselves, because of the greater numbers, will be more slender and will make a softer turf.

[62] Cf. Bailey, "The Survival of the Unlike," 194, 196, 1896.

ATTITUDE OF BIOLOGISTS

It may be asked to what extent biologists make use of the theorem of Le Chatelier as a working hypothesis in studying the effect of external conditions. So far as I can learn, nobody makes any active use of it, and many biologists would deny the applicability of the theorem.

Darwin[63] began by attributing very little to the direct action of the climate, etc.; but later he stated that more weight should have been allowed to the direct action of the environment, *i. e.*, food, climate, etc., independently of natural selection. He says[64] that it is "probable that variability is directly or indirectly caused by changed conditions of life. Or, to put the case under another point of view, if it were possible to expose all the individuals of a species during many generations to absolutely uniform conditions of life, there would be no variability." In spite of this he states[65] explicitly that long-continued action of a different climate has produced differences in American trees which are of no especial service to them.

Nägeli's[66] "extensive cultural experiments with alpine *Hieracia* led him to form the opinion that the changes which are induced by an alteration in the food-supply, in climate or in habitat, are not inherited and are therefore of no importance from the point of view of the production of species."

[63] Cf. Schwalbe, "Darwin and Modern Science," 125, 1909.

[64] Darwin, "Animals and Plants under Domestication," 2d ed., 2, 242, 1890.

[65] Darwin, "Animals and Plants under Domestication," 2d ed., 2, 271, 1890.

[66] Cf. Klebs, "Darwin and Modern Science," 225, 1909.

De Vries[67] is distinctly not prepared to admit that mutations are described by the theorem of Le Chatelier.

The origin of new species, which is in part the effect of mutability, is, however, due mainly to natural selection. Mutability provides the new characters and new elementary species. Natural selection, on the other hand, decides what is to live and what to die. Mutability seems to be free, and not restricted to previously determined lines. Selection, however, may take place along the same main lines in the course of long geological epochs, thus directing the development of large branches of the animal and vegetable kingdom. In natural selection it is evident that nutrition and environment are the main factors. But it is probable that, while nutrition may be one of the main causes of mutability, environment may play the chief part in the decisions ascribed to natural selection. Relations to neighboring plants and to injurious or useful animals, have been considered the most important determining factors ever since the time when Darwin pointed out their prevailing influence.

There is nothing very definite to be obtained from Klebs.[68]

The dependence of *variable internal* on *variable external* condition gives us the key with which research may open the door. In the lower plants this dependence is at once apparent, each cell is directly subject to external influences. In the higher plants with their different organs, these influences were transmitted to cells in course of development along exceedingly complex lines. In the case of the growing point of a bud, which is capable of producing a complete plant, direct influences play a much less important part than those exerted through other organs, particularly through the roots and leaves, which are essential in nutrition. These correlations, as we may call them, are of the greatest importance as aids to an understanding of form-production. When a bud is produced on a particular part of a plant, it undergoes internal modifications induced by the influence of other organs, the activity of which is governed by the environment, and as the result of this it develops along a certain direction; it may, for example, become a flower. The particular direction of development is determined before the rudiment is differentiated and is exerted so strongly that further development ensues without interruption, even though the external conditions vary considerably and exert a positively inimical influence: this produces the impression that development proceeds entirely independently of the outer world. The wide-spread belief that such independence exists is very premature and at all events unproven.

The state of the young rudiment is the outcome of previous influences of the external world communicated through other organs. Experiments show that in certain cases, if the efficiency of roots and leaves as organs concerned with nutrition is interfered with, the production of flowers is affected, and their characters, which are normally very constant, undergo far-reaching modifications. To find the right moment at which to make the necessary alteration in the environment is indeed difficult and in many cases not yet possible. This is especially the case with fertilized eggs, which in a higher degree than buds have acquired, through parental influences, an apparently fixed internal organization, and this seems to have predetermined their development. It is, however, highly probable that it will be possible, by influencing the parents, to alter the internal organization. and to switch off development on to other lines.

Bailey is quite clear that the environment has a marked effect upon plants; but he is very far from formulating that effect, as the following quotations will show:[69]

These differences [between individual plants] arise as a result of every impinging force, soil, weather, climate, food, training, conflict with fellows, the strain and stress of wind and wave, and insect visitors, as a complex resultant of many antecedent external forces, the effects of crossing, and also as the result of the accumulated force of mere growth; they are indefinite, non-designed, an expression of all the various influences to which the passive vegetable organism is or has been exposed; these differences which are most unlike their fellows or their parents find the places of least conflict and persist because they thrive best, and thereby impress themselves best upon their offspring.

It is not too much to ask of climatology that it shall tell us why the northern climates develop saccharine elements and high colors, and why the

[67] "Darwin and Modern Science," 77, 1909.

[68] "Darwin and Modern Science," 228, 235, 242, 1909.

[69] Bailey, "The Survival of the Unlike," 32, 309, 1896.

Wisconsin-Minnesota area produces such remarkable waxen and pruinose tints. The influence of the climate is nowhere so easily traced, perhaps, as in the business of seed growing. Every seedsman knows that certain climates are not only best adapted to growth of certain seed crops, but that they exert a profound influence upon the character of the product grown by them. The study of all these interrelations of climate and plant life falls into three subjects: phenology, or the study of the periodic phenomena of plants, a subject which loses half its value when considered, as it usually is, without reference to the visible attending features of climate; acclimatization, or a consideration of the means by which plants adapt themselves to climates at first injurious; and secondary variations of plants induced by climate environment.

The burden of my plea is twofold: First, while not discouraging the instrumental or conventional study of climate, I would encourage its study in terms of plant life. Second, it is essential that the synchronisms of local climate and the phenomena of plants be given the closest attention.

Sedgwick[70] is quite clear as to the direction of the changes; but I can not see that he makes any actual use of this as a working hypothesis.

It is a property of living matter to react in a remarkable way to external forces without undergoing destruction. The life-cycle, of which the embryonic and larval periods are a part, consists of the orderly interaction between the organism and its environment. The action of environment produces certain morphological changes in its organism. These changes enable the organism to come into what is practically a new environment, which in its turn produces further structural changes in the organism. These in turn enable, indeed necessitate, the organism to move again into a new environment, and so the process continues until the structural changes are of such a nature that the organism is unable to adapt itself to the environment in which it finds itself. The essential condition of success in this process is that the organism should always shift into the environment to which the new structure is suited —any failure in this leading to the impairment of the organism. In most cases the shifting of the environment is a very gradual process (whether consisting in the very slight and gradual alteration in the relation of the embryo as a whole to the egg-shell or uterine wall, or in the relations of its parts to each other, or in the successive phases of adult life), and the morphological changes in connection with each step of it are but slight. But in some cases jumps are made such as we find in the phenomena known as hatching, birth and metamorphosis. This property of reacting to the environment without undergoing destruction is, as has been stated, a fundamental property of organisms. It is impossible to conceive of any matter to which the term living could be applied being without it. And with this property of reacting to the environment goes the further property of undergoing a change which alters the relation of the organism to the old environment and places it in a new environment.

This quotation is not what we want, because Sedgwick is considering the life cycle of an individual, which is not our problem at all. It is good as far as it goes, however, and it is the best that I have been able to find.[71]

We get the opposite extreme with Bateson,[72] who says:

To those who have made no study of heredity it sometimes appears that the question of the effect of conditions in causing variation is one which we should immediately investigate, but a little thought will show that before any critical inquiry into such possibilities can be attempted, a knowledge of the working of heredity under conditions as far as possible uniform must be obtained.

The cap seems to fit and I am quite ready to put it on. Bateson's argument is simply that a change due to reversion might be interpreted as due to a change in environment. This is a possible source of error; but it is one which can be eliminated by making enough experiments and by making experiments with different species of plants. It is hardly conceivable that a reversion to an albino variety, for instance, should coincide with a given change of environment in every experiment and with every kind of plant. On the other hand,

[70] "Darwin and Modern Science," 177, 1909.

[71] Cf. also Bourne, SCIENCE, 32, 738, 1910.

[72] "Darwin and Modern Science," 95, 1909.

it is always a good plan to do the easiest things first, partly because it takes less time to get results, but chiefly because the easy things usually throw light on the hard ones. We know that suitable changes in the environment, if made at a suitable time, will cause such changes in the organism that the next generation differs from the first. It is a very difficult problem to determine the intermediate steps; but it is a relatively simple one to determine what change in the second generation is the result of a change in a single factor of the environment. This is a problem which has not been attacked by the biologist in any systematic fashion, and it is a problem which will be greatly simplified by an intelligent application of the theorem of Le Chatelier.

The view of the biologists seems to be that each generation always varies spontaneously from the preceding one to a greater or lesser extent, and that these variations are reproduced more or less completely in the succeeding generation. By the survival of the fittest we eventually get a race which is better adapted to the local conditions than the one from which we started.

The view that I have outlined is that the external conditions tend to produce such changes in the organism that the next generation varies in such a way as to be more adapted to local conditions. By the survival of the fittest and by the continued action of the external conditions, we eventually get a race which is better adapted to the local conditions than the one from which we started.

We reach the same conclusion whichever way we consider the matter. The two views are not mutually exclusive because it is quite possible to consider the variation due to the external conditions as superimposed on the spontaneous variations. If we are to decide between the two points of view, it must be on other grounds than qualitative results. To me, the phrase "spontaneous variation" seems merely another way of expressing our ignorance. I do not believe in a variation without a cause. If we go back far enough, all variations must be the result of varying external conditions and the real problem is to show what part of any given variation in any given organism is due to the effect of external conditions on the preceding generation and what part is due to the effect of external conditions on still earlier generations. What we study under heredity, as the word is usually used, is the transmitted effect of varying external conditions upon the more or less remote ancestors.

Another objection to the biologist's point of view is that it has not worked out well practically. Being obsessed by the idea of spontaneous variation, he has very rarely taken the trouble to work out carefully the relation between each particular factor of the external conditions and the acquired characteristics of the organism which has become better adapted to its surroundings. If the biologist had had the theorem of Le Chatelier as a guiding hypothesis, he would not have made this mistake and he would often have done better and more careful work.

I have tried to show that the theorem of Le Chatelier is a universal law and that it is consequently of great value in enabling us to correlate old facts and to discover new ones.

WILDER D. BANCROFT
CORNELL UNIVERSITY

THE SEVENTEENTH INTERNATIONAL CONGRESS OF AMERICANISTS

THE second session of the seventeenth International Congress of Americanists was held

in the Museo Nacional, Mexico City, Mexico, September 8–14, 1910.[1] In addition to Mexico, the following countries were represented by official delegates present: Austria-Hungary, China, Costa Rica, Cuba, France, Germany, Guatemala, Holland, Italy, Japan, Portugal, Salvador, Spain and the United States of America. There were also in attendance delegates from a number of learned societies and other institutions from various parts of the world.

The United States government was represented by Professor Franz Boas, Professor Roland B. Dixon, Dr. Aleš Hrdlička and Dr. Alfred M. Tozzer. The state of Louisiana was represented by Judge Joseph A. Breaux. Delegates from several American institutions were present: Drs. Pliny E. Goddard and Herbert J. Spinden, American Museum of Natural History; Mr. Stansbury Hagar, Brooklyn Institute of Arts and Sciences; Mr. William Beer, Howard Memorial Library; Mrs. Zelia Nuttall, University of California; Professor George B. Gordon, University of Pennsylvania; and Dr. George Grant MacCurdy, Yale University. All these are members of the American Anthropological Association.

To any one interested in American archeology Mexico offers remarkable attractions, not only in the priceless treasures of the Museo Nacional, but also in the number and grandeur of the prehistoric ruins. The author spent five weeks in excursions to various sites, and in study at the museum. His program was no doubt duplicated by many other visiting members. The only official excursions announced by the committee of organization were those to Teotihuacan, Mitla and Xochicalco. The first of these took place during the congress. To it were invited not only the members of the Americanist Congress but also the official delegates to the Mexican centenary, the hosts being the department of foreign affairs as well as that of public instruction and fine arts. It was made the occasion for the opening of the new museum at the ruins of Teotihuacan. An elaborate dinner was served in the celebrated grotto near the Pyramid of the Sun, at which speeches were made by both the secretary of foreign affairs, Señor Creel, and the secretary of public instruction and fine arts, Señor Sierra. The excursions to Mitla and Xochicalco took place after the congress and were unfortunately marred by some confusion and delay.

Among the centennial attractions that were of special interest to the Americanists was the great historic pageant occurring the day after the congress closed. The first section of the pageant numbering 839 persons, dealt with the epoch of the conquest, particularly the first meeting between Montezuma and Cortes (1519). The sections which followed represented the epochs of Spanish dominion and of independence, respectively.

There were a number of special social functions in honor of the congress, including receptions by the minister of public instruction and fine arts, and by Mrs. Zelia Nuttall at her interesting home, Casa Alvarado, in the historic old suburb of Coyoacan.

The mode of selection of the council emphasized a weakness of the statutes that should be remedied by amendment at the next congress. So far as I have been able to ascertain, no change has been made in the statutes since the close of the first congress.[2] Article 7 of the statutes is as follows:

> The Assembly elects the Members of the Council of which the number is determined by the Committee of Organization.
>
> Each nationality should, at all events, be represented by at least one Member.

This article gives the committee of organization power to limit the number of the council and thus in a measure to determine its personnel. By its very nature the committee of organization is temporary and a local body; while the congress itself is international. Not a single member, for example, of the committee of organization of the immediately preceding congress in Vienna was on the com-

[1] A session had already been held in Buenos Aires during the month of May.

[2] Congrès intern. des Americanistes, Compte rendu de la première session, t. II., p. 170, Nancy, 1875.

mittee of organization of the congress in Mexico. The latter committee decided to limit the council to governmental delegates. In doing so it took into the council diplomats and the judge of a state court; excellent men all of them, but only momentarily interested in the purposes for which the congress exists. At the same time it left out of the council those who have been attending the congresses for years, some of whom had previously sat in its councils, and including professional Americanists attached to and delegated by some of the foremost museums and institutions of learning in America. If the last paragraph of article 7 can be construed in such a manner as to take the control of the congress away from those, but for whom it could not exist, it should be amended at the first opportunity; and the power to limit the number of the council should be transferred from the ephemeral committee of organization, often composed of members who never attended a congress before and who will probably never do so again, to the "Assembly" of members present, which in a measure, at least, is a perpetual body.

During the congress, a committee of delegates from Mexico, France, Germany, Harvard University, the University of Pennsylvania and Columbia University met and agreed upon the foundation of an international school of archeology in the city of Mexico. Other governments and universities may take part in this movement by subscribing to the by-laws (now in process of ratification). The present director of the school is Professor Eduard Seler.

The next congress will be held in London during the month of September, 1912.

The following papers were presented and will be published in the *Compte rendu* of the congress:

"La etnología de las razas indígenas que poblaron las comarcas del sur de Tamaulipas," Alejandro Prieto.

"Contribution to the Anthropology of Peru," Alês Hrdlicka.

"La huella más antigua quizá del hombre en la península de Yucatan; Estudio de la industria prehistórica de Concepción (Campeche)," Jorge Engerrand.

"Pruebas geológicas de que la parte norte de la peninsula yucateca no ha podido ser habitada por el hombre durante la época cuaternaria," Jorge Engerrand.

"Un caso de cruzamiento entre un Chino y una Yucateca de origen indígena," Jorge Engerrand.

"Quelques observations sur l'art de guerir chez certains tribus nomades du nord du Mexique," Theo. Dupoyet.[3]

"La trepanacion entre nuestros aborígenes," Alberto M. Carreño.

"El rayo de luz y la cronología india," Abraham Castellanos.

"Sobre correcciones del período de Venus en los manuscritos historicos mexicanos," Hermann Beyer.[3]

"Zodiacal Symbolism of the Mexican and Maya Month- and Day-signs," Stansbury Hagar.

"The Celestial Plan of Teotihuacán," Stansbury Hagar.

"El zodiaco de los Incas en comparacion con el de los Aztecas," Arnolfo Krum Heller.

"Los grandes ciclos de la historia maya según el manuscrito del Chumayel," Juan Martinez Hernandez.

"La medicina entre los Indios mexicanos antes de la conquista," Francisco A. Flores.

"Publicaciones nuevas sobre la linguistica americana," Franz Boas.

"A Classification of Maya Verbs," Alfred M. Tozzer.

"Lenguas de la familia nahuatlana; su clasificacíon," Francisco Belmar.

"Dios ¿Que idea tenian de el los antiguos mexicanos?" Cecilo A. Robelo.[3]

"Idolatrias y supersticiones de los Indios," Vicente de P. Andrade.

"El verdadero concepto de la etnología: La ciencia de gobernar," Andres Molina Enríquez (read by title).

"Algunas lenguas que se hablan en el sur del Estado de Chiapas," Carlos Sapper.[3]

"The Language of the Tano Indians of New Mexico," John P. Harrington.[3]

"Colon y la lengua castellana y las americanas," Antonio Sánchez Moguel.

[3] Read by title, but will be published in the *Compte rendu* of the congress.

"Itinerario de la expedición de Hernán Cortés á Hibueras," Marcos E. Becerra.[3]

"El testamento de Hernán Cortés," Francisco Fernández del Castillo.

"Une mappe inédite de 1534, avec texte espagnol au verso," Louis Capitan.

"L'œuvre géographique de Humboldt en Mexique," Eugen Oberhummer.

"Les observations géographiques dans les lettres de Cortes," Eugen Oberhummer.[3]

"Resumen de mis estudios de documentos del siglo XV contenidos en el Archivo General y Público de la Nacion," Zelia Nuttall.

"Algunos de los primeros establecimientos de instrucción en el Reino de Nueva Galicia," Francisco Escudero.[3]

"Estudio geografico, historico, etnografico y arqueologico de la Republica de El Salvador," Leopoldo A. Rodríguez.

"Breves notas sobre la historia, la arqueología y la etnogenia del territorio de Tepic," Francisco A. Flores.

"Notes sur le Mexique," Auguste Genin.[3]

"A Manuscript in Washington," Charles Warren Currier.[3]

"El Votan," Enrique Santibanez.

"Photographic Notes on the Pueblo Indians of Southwestern United States," Frederick I. Monsen.[3]

"Estudio sobre la teoria del origen oriental de algunas razas americanas," Manuel Cortes.[3]

"Chronological Sequence of the Sculptures of Copan," Herbert J. Spinden.

"Sobre algunas representaciones del dios Huitzilopochtli," Hermann Beyer.[3]

"Une figuration de Quetzalcoatl sous forme de serpent emplumé enroulé, provenant de Mexico," Louis Capitan.

"La stylisation de la figure humaine et la représentation des sacrifices humains sur les vases peints preincasiques de Vazca (Pérou)," Louis Capitan.

"Miniature Clay Temples of Ancient Mexico," H. Newell Wardle.

"An Aztec 'Calendar Stone' in the Yale University Museum," George Grant MacCurdy.

"Elements of Kato, an Athabascan Dialect," Pliny E. Goddard.

"Las ruinas de Uxmal," Eduardo Seler.

[3] Read by title, but will be published in the *Compte rendu* of the congress.

"The Ruins of Northeastern Guatemala," Alfred M. Tozzer.

"Un dato sobre la evolución del alfabeto entre los azteca y los maya," Jesús Díaz de León.

"La reparacion de las ruinas de Xochicalco," Leopoldo Batres.

"Estudio comparativo de dos documentos historicos," Antonio Garcia Cubas.[3]

"Some Points in Louisiana Cartography," William Beer.

"Three Centuries of Total Eclipses of the Sun in Mexico: 1850–2150," David Todd.[3]

"Central and South America—Governmental Cooperation the Key to Great Opportunity," Louis E. Walkins.[3]

"Résumé of the Papers, read at the Sixteenth Congress held at Vienna, on Mexican History, Architecture, Art, etc." Franz Heger.

George Grant MacCurdy
Yale University,
New Haven, Conn.

THE NEW PLAN FOR ADMISSION TO HARVARD UNIVERSITY

On January 17 the Faculty of Arts and Sciences of Harvard University voted to adopt the plan of admission as given below as an alternative to the system at present in force. The plan, it will be noted, is a compromise between the certificate and examination methods. It is intended to obviate "cramming" for examinations and to improve articulation with secondary schools, especially public high schools.

A. Evidence of the completion of an approved secondary school course.

1. Tabulated statement. A candidate shall present to the committee appointed to administer this plan evidence as to his secondary school work in the form of an official detailed statement showing: (*a*) The subjects studied by him and the ground covered. (*b*) The amount of time devoted to each. (*c*) The quality of his work in each subject.

2. Approved school course. An "approved secondary school course" must (*a*) extend over four years; (*b*) concern itself chiefly with languages, science, mathematics and history. No one of these four subjects may be omitted. At least two studies of a candidate's school program must be carried to the stage required by the present advanced examinations of Harvard College, or by

the equivalent examinations of the College Entrance Examination Board.

B. Examination in four subjects.

1. Subjects. A candidate who presents evidence that he has satisfactorily completed an "approved secondary school course," shall offer himself for examination in the four subjects named below. A satisfactory record in these examinations shall admit to Harvard College without conditions: (*a*) English, (*b*) Latin, or for candidates for the degree of S.B., French or German, (*c*) Mathematics, or Science (Physics or Chemistry), (*d*) any subject (not already selected under (*b*) or (*c*) from the following list: Greek, French, German, History, Mathematics, Chemistry, Physics.

2. The examination papers. (*a*) The preparation presupposed by the examination papers in the several subjects shall not be less than is ordinarily necessary for the present elementary examinations. The papers shall contain a sufficient number of alternative questions, and shall be so framed as to permit variety in the methods of school instruction. They shall also include advanced questions, thus permitting each student to reveal the full amount and the quality of his attainment. In any subject offered for examination which the candidate has pursued to an advanced grade he must present evidence of that grade of attainment. The papers shall not, however, presuppose a greater length of preparation than is ordinarily required for the present Harvard examinations. (*b*) Time of examinations. The four examinations must be taken at one time, in either June or September. (*c*) Judging the examination books. A copy of the candidate's school record shall be given to the readers of the examinations. In judging the books the examiner shall submit a full statement of his opinion of each book. In addition, at the option of the examiner, a grade may be given.

3. A satisfactory record. A "satisfactory record" shall not be construed to require that a candidate attain distinction in all four subjects, but shall mean that in the judgment of the Committee on Admission the candidate's examination record as a whole, when viewed as the basis for a general estimate of his quality, is such as to make his admission to Harvard College advisable.

THE NEW YORK ZOOLOGICAL SOCIETY

THE seventeenth annual meeting of the New York Zoological Society was held at the Hotel Waldorf-Astoria, January 10, 1911, at 8.30 o'clock P.M. Mr. Henry Fairfield Osborn, president of the society, presided and Mr. Madison Grant, the chairman of the executive committee, laid before the meeting the report of that committee for the year 1910. Colonel C. J. Jones gave the first public exhibition of a series of moving pictures showing the roping and capture of living wild animals in British East Africa, including lions, rhinoceroses and various antelopes, and Mr. Roy C. Andrews showed a series of pictures taken during the past season of the capture of whales in Japanese waters.

The report of the executive committee covered the following matters:

During the year $12,848 have been expended for the purchase of animals, chiefly for the purpose of strengthening the collections in general, from a zoological point of view, rather than for the purchase of costly special features. As a result of this policy, the collections, as a whole, are to-day stronger in rare species, and also in number of individuals, than at any previous period. The health of the collections at the park and the aquarium has been maintained at a high standard throughout the year, and there have been few losses of importance.

Administration Building.—The administration building was completed and thrown open to the use of the members on November 20, 1910. It provides accommodations for the members of the society, and it is hoped that members and their guests will make full use of the opportunities afforded.

New Buildings.—The following new structures are under way at the present time: Ten additional bear dens and cages, eagles and vultures aviary, and a winter house for tropical birds of prey. Plans for a zebra house have been completed, and the contract, it is hoped, will be awarded during the winter.

National Collection of Heads and Horns.—The National Collection of Heads and Horns has been greatly increased during the year and now contains 688 specimens. A few of the most notable additions are: Head of square-mouthed rhinoceros from Col. Theodore Roosevelt; bongo, from Mr. James L. Clark; New Brunswick moose, from Mr.

Edwin C. Kent, and the following heads from Mr. H. Casimir de Rham: Karelin sheep, Turkestan sheep, Astor markhor, two Himalayan ibex, Quchim buffalo, Newfoundland caribou, musk ox and sable antelope.

Library.—The administration building will also contain the library, which now numbers 1,378 volumes. A fund of $2,000 was provided by two of the friends of the society for this purpose.

Gifts.—Among the most notable gifts have been a remarkable series of arctic animals from Mr. Paul J. Rainey, as follows: Six musk ox, two walrus, two polar bears, one blue fox.

Pheasant Expedition.—The New York Zoological Society expedition for pheasants is now in Siam, and is expected to return to New York some time during the summer of 1911. The expedition has been successful in securing specimens, living and dead, of nearly all the pheasants in the districts visited.

Aquarium.—The New York Aquarium has, in its present building, nearly reached the limit of its capacity both for its collections and for visitors. The enormous attendance makes it necessary to provide a larger and more modern building, and several studies of plans for this purpose have been made. The city will be asked to provide the necessary funds for the new aquarium.

SCIENTIFIC NOTES AND NEWS

Sir Francis Galton, eminent for his contributions to geography, meteorology, biology, anthropology and psychology, died on January 18, at the age of eighty-eight years.

At the annual meeting of the trustees of the Carnegie Institution of Washington, Dr. Simon Flexner, of the Rockefeller Institute of Medical Research, Mr. Robert S. Brookings, of St. Louis, and Dr. Henry Pickering Walcott, of Boston, were elected to membership in the board.

Sir John Murray will give a memorial address on "The Life and Scientific Works of Alexander Agassiz," at Sanders Theater, Harvard University, on Tuesday evening, February 14.

The next Faraday lecture of the Chemical Society of London is to be given on June 14 by Professor Theodore W. Richards, of Harvard University, in Faraday's lecture-room at the Royal Institution on Albemarle Street, London.

Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, has been elected an associate of the Royal Academy of Science at Belgium, in the section of natural science; and also an honorary foreign member of the Academy of Medicine of Belgium.

Dr. Alěs Hrdlička has been made a corresponding member of the Academy of Sciences, Prague.

Sir David Gill has been elected a foreign member of the Swedish Royal Academy of Sciences, Stockholm.

M. Edouard Branly has been elected a member of the Paris Academy of Sciences in the section of chemistry. He received thirty votes, twenty-eight votes being cast for Madame Curie.

Dr. David Ferrier, F.R.S., emeritus professor of neuropathology in King's College, London, has been knighted.

Professor M. E. Cooley, dean of the department of engineering of the University of Michigan, was given the degree of doctor of engineering by the University of Nebraska on January 18.

The Geological Society of London will this year award its medals and funds as follows: The Wollaston Medal to Professor Waldemar C. Brögger, Sc.D.; the Murchison Medal to Mr. Richard H. Tiddeman, M.A.; the Lyell Medal to Dr. Francis A. Bather, M.A., and Dr. Arthur W. Rowe; the Bigsby Medal to Dr. O. Abel; the Wollaston Fund to Professor O. T. Jones, M.A.; the Murchison Fund to Mr. Edgar S. Cobbold; the Lyell Fund to Professor Charles G. Cullis, D.Sc., and Mr. John F. N. Green.

Additional grants have been made to Professor T. W. Richards and to Professor G. P. Baxter, of Harvard University, of $2,500 and

$1,000, respectively, as research associates of the Carnegie Institution of Washington.

DR. G. CARL HUBER, professor of histology and embryology in the department of medicine of the University of Michigan, has tendered his resignation as secretary. Dr. Huber has been made head of the new department of embryology at the Wistar Institute of Anatomy, Philadelphia, and will spend part of his time there. An arrangement has been effected for the next two years. By long service Dr. Huber has earned a year's leave of absence, which the regents have consented to allow in two periods of six months each. During the next semester Dr. Huber will be at the Wistar Institute, and he will return to the University of Michigan for the first semester of next year. Dr. C. W. Edmunds, professor of therapeutics and materia medica, has been elected secretary of the department.

PROFESSOR R. A. HARPER, head of the department of botany at the University of Wisconsin, has left for the University of California, where he will lecture during the remainder of the present academic year. Professor George J. Pierce, of Stanford University, will be acting professor of botany at the University of Wisconsin.

DR. ARTHUR W. WEYSSE, professor of biology at Boston University, has started on a trip around the world on sabbatical leave of absence. He will sail from San Francisco on February 8, for Hawaii and Japan, and will be away about eight months.

ON January 20 Professor Arthur Michael lectured before the members and research students at the department of chemistry at Clark University on his recent observations in connection with reversible organic chemistry. A result of the greatest importance is Professor Michael's discovery of an apparently new factor influencing the velocity of organic reactions.

DR. GEORGE T. MOORE, of the Shaw Botanical Gardens at St. Louis, gave a public lecture before the Society of Sigma Xi, of Cornell University, on January 17, on "Some Striking Advances in Botanical Science and the Application of these in Practical Affairs."

ON January 13 Professor A. E. Kennelly, of Harvard University, delivered a lecture before the Society of Sigma Xi at the University of Pennsylvania on "Wireless Telegraphy and Telephony as compared with Wire Telegraphy and Telephony."

A SPECIAL meeting of the Geological Conference was held at Harvard University on January 31, when Mr. Frank A. Perret, of Naples, Italy, spoke on "Volcanoes and Volcanic Action," with illustrations. Mr. Perret has spent the last six years in the study of volcanic problems, and has lived on Vesuvius, Etna and Stromboli during their recent eruptions.

AT a general meeting of the Association of Public School Science Masters held in London on January 11 and 12, the president, Sir Edwin Ray Lankester delivered an address on "Compulsory Science *versus* Compulsory Greek."

AT a meeting of the Royal Geographical Society on January 16 Dr. Johan Hjort gave a detailed account of the Michael Sars North Atlantic deep sea expedition of 1910, which he, with Professor H. H. Grau, Dr. Helland-Hansen, Mr. E. Koefoed, and Captain Thor Iversen, undertook at the suggestion and at the expense of Sir John Murray, who himself accompanied them.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board has made conditional appropriations as follows: Brown University, $100,000; Carleton College, $100,000; Colorado College, $50,000; Dakota Wesleyan University, $50,000; Denison University, $75,000; Fisk University, $60,000; Mount Holyoke College, $100,000; Randolph-Macon College, $50,000; Swarthmore College, $75,000; Wesleyan College for Women, $50,000.

THE bill increasing the annual appropriation from the state of Vermont to Middlebury College by $7,600 has been signed by Governor Mead. This will make the state appropriation to Middlebury $16,000 a year, beginning on July 1. The increase is "to provide additional instruction in the departments

of pedagogy, in forestry and in scientific branches related to the industries of Vermont."

A GIFT of $50,000 to Cornell University by Mrs. Florence O. R. Lang, of Montclair, N. J., will be used in the construction of a new building to house the shops of the Sibley College of Mechanical Engineering.

THE will of Octavia Williams Bates, of Baltimore, leaves to the library of the department of law of the University of Michigan, a bequest of $20,000. A bequest of $5,000 is made to the Detroit High School Scholarship Fund Association, an organization designed to lend money to graduates of the Central High School of Detroit, so that they may attend the university. A number of other legacies for private and public purposes are provided. When all these are settled, the remainder of the estate is to go to the University of Michigan. Miss Bates was a graduate of the literary department of the university in 1877, and of the law in 1896.

DR. A. M. HILTEBEITEL has been appointed instructor in mathematics at the University of Pennsylvania. Dr. H. B. Smith has been appointed instructor in the same department for the ensuing term, to fill the vacancy caused by the temporary absence of Professor Evans.

AT the Massachusetts Agricultural College Dr. Guy Chester Crampton has been appointed associate professor of entomology. Dr. Crampton is a native of Alabama. He graduated from Princeton in 1904, took two years of graduate work at Cornell University, receiving his M.A. there in 1905, followed by two years at the universities of Freiburg, Munich and Berlin, where he received his Ph.D in 1908. He was an instructor in biology at Princeton from 1908 to 1910 and since the summer of 1910 has been professor of zoology at Clemson College.

DISCUSSION AND CORRESPONDENCE

NUMERICAL NOMENCLATURE

THE recent proposal of Professor James G. Needham[1] to use numbers and symbols as aids in zoological nomenclature, which has been sympathetically discussed by Professor Henry B. Ward[2] and destructively criticized by Professor T. D. A. Cockerell[3] in the columns of SCIENCE, has reminded me that one of the earliest attempts at entomological classification employed the numerical method which Professor Needham appears to think likely to prove useful. In the year 1766 (one hundred and forty-five years ago) the Rev. Jacob Christian Schaeffer, D.D., began the publication of an illustrated work upon the insects found in the vicinity of Regensburg, his home, and brought it to a conclusion in the year 1779. The title of the work is given in Latin and German as follows: "Icones Insectorum circa Ratisbonam indigenorum coloribus naturam referentibus expressæ. Natürlich ausgemahlte Abbildungen Regensburgschen Insecten." The indices of the several volumes show that they might have served as models for Professor Needham. Opening at random I find the following in volume I.:

		No.
CICINDELA,		1
		2
		3
		4
		5
SPHINX.		
		No.
	Fam. I. Al. angul.	1
		2
		3
		4
		5
		6
	Fam. II. Al. int. caud. simpl.	1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
	Fam. III. Al. int. caud. pil.	1
		2

[1] SCIENCE, N. S., Vol. XXXII., p. 295.

[2] SCIENCE, N. S., Vol. XXXIII., p. 25.

[3] SCIENCE, N. S., Vol. XXXII., p. 428.

In volume III. we find *Hesperia malvæ* Linn. designated as the "Siebender sechsfüssiger Tagfalter mit schiefen Flügeln," etc.

"Verily, there is nothing new under the sun!"

For my part, I sympathize with all attempts to secure a fixed and simple system of nomenclature, but to revert to what were the methods of good old Dr. Jacob Christian Schaeffer in this twentieth century is not, in my opinion, the correct solution of our difficulties.

The troubles of the student of nomenclature are not, I suspect, as great as they appear to be to those who do not possess the necessary apparatus of books and who have devoted more time to questions of morphology than to questions of taxonomy. I have not at present the leisure to take up the questions involved in this discussion as I should like to do, but simply wish to remind the readers of SCIENCE that the method of numerical designations was employed nearly a century and a half ago for an extensive fauna, and that the numbers for a good many species in various genera are therefore already "preoccupied."

W. J. HOLLAND

SCIENTIFIC BOOKS

Respiratory Calorimeters for Studying the Respiratory Exchange and Energy Transformations of Man. By FRANCIS G. BENEDICT and THORNE M. CARPENTER. Published by the Carnegie Institution of Washington. 1910. Pp. 210.

This contains a full description of the latest models of respiratory calorimeters. Two are mentioned, the "chair calorimeter" designed for individuals for six- to eight-hour periods during which they can remain comfortably seated in a chair, and the "bed calorimeter" for use at night or for the sick or bed-ridden.

The measurements of heat eliminated by man as made by this apparatus are based upon the fact that the subject is enclosed in a heat-proof chamber through which a current of cold water is constantly passing. The amount of water is carefully weighed. The temperatures of the water entering and leaving the chamber are accurately recorded at frequent intervals. The walls of the chamber are held adiabatic, thus preventing a gain or loss of heat. Thermo-electric couples connected with a galvanometer notify an observer of temperature changes of the walls. The observer then corrects this by arbitrarily cooling or heating the outer metal walls, a second cold water current accomplishing the former and electric wiring the latter, both systems being outside the inner chamber. The heat given to the first described water current circulating within the inner chamber, is exactly equal to the heat eliminated by radiation and conduction by the subject. To determine the total heat elimination, the latent heat of water vapor evaporated from the skin and lungs must also be added. The sensitiveness of this apparatus is very great. Foreigners as well as fellow countrymen have pronounced it a wonderful machine. In addition to the determination of heat elimination, the carbonic acid outgo and oxygen ingo are determined through an accessory apparatus which provides for the analysis of the circulating air.

The apparatus is costly in the first instance and requires many workers to control. In the hands of Dr. Benedict it has received notable improvements, and it is both wise and fortunate that he has had the splendid generosity of the Carnegie Institution to support his undertaking.

GRAHAM LUSK

The Metabolism and Energy Transformations of Healthy Man during Rest. By FRANCIS G. BENEDICT and THORNE M. CARPENTER. Published by the Carnegie Institution of Washington. 1910. Pp. 255.

This work contains a very valuable compilation of statistics obtained from observation on many normal men who had been occupants of the respiration-calorimeter of Atwater, Rosa and Benedict. As a rule records of the protein metabolism are not recorded, which leaves an important gap unfilled. The authors state that the work of Zuntz and others who used respiration apparatus of the Zuntz type is "as accurate as can be expected with apparatus of this type." The recently published work of Durig, how-

ever, shows that the results of oxygen absorption and carbondioxide elimination as determined by the Benedict calorimeter and the Zuntz apparatus are identical. There is therefore no doubt that the preeminent feature of the apparatus used by Benedict is the calorimetric determinations.

The authors find that the average heat production for fifty-five subjects during waking hours is 97.1 total calories, 1.52 per kilogram of body weight, and 49.2 per square meter of body surface, per hour. These records are 35 per cent. above the requirements in sleep. Further experiments showed an average requirement of 17.8 additional calories when a subject undressed, weighed himself and dressed again. An important generalization is that the pulse rate is more or less parallel to the total metabolism.

This book suffers very greatly from a fault that has pervaded the publications of the Nutrition Laboratory, both at Boston and at Middletown, and that is that the new discoveries are not sharply defined as separate from well-known facts. This fault occurs in Benedict's splendid monograph on "Inanition" where the one new fact, the quantitative determination of the amount of glycogen oxidized on the first and second days of fasting is passed over without emphasis.

The authors make the following statement: "A striking series of experiments has demonstrated very clearly that a change from a diet poor in carbohydrates to one rich in carbohydrates is accompanied by a considerable retention of water by the tissues of the body." This however is not an original observation, having been noted by Bischoff and Voit, fifty years ago.

The world owes a great debt to the work of the Carnegie Nutrition Laboratory and its forerunner in Middletown, which no one can gainsay. Criticism is offered in the spirit of Pflüger who held it to be the mainspring of every advance and the Altmeister adds, "deshalb übe ich es."

GRAHAM LUSK

The Elements of the Theory of Algebraic Numbers. By L. B. REID. New York, The Macmillan Company. 1910. Pp. xix + 454.

The title of this book is misleading, as it treats of no algebraic numbers other than quadratic; it can not be said to present even the elements of the theory of algebraic numbers. The author devotes 150 pages to the elementary congruencial properties of rational numbers and 300 pages to quadratic numbers. In view of the intimate relations between quadratic forms and the numbers and ideals of a quadratic field, the omission of an account of quadratic forms is certainly a serious defect in a book having the aims of the present one.

In a review of a book of the character of the present text, one has only to discuss questions of pedagogy. The author desires to bring out a closer relation between rational numbers and quadratic numbers. This he accomplishes by complicating the elements of rational numbers with the unnecessary machinery of quadratic numbers! We find on page 91 Wilson's theorem stated in the form

$$r_1 r_2 \cdots r_k + 1 \equiv 0 \pmod{p}, \quad k = \phi(p),$$

where $r_1, \cdots, r_k$ form a complete set of residues modulo p, a prime. A similar unnecessary complication is met on page 105. Positive and negative primes p are used, so that one must face $\phi(p) = |p| - 1$.

On page 247 the "introduction of the ideal" should read introduction of ideals. After stating formally theorem A and devoting fifteen lines to its proof, the author informs us that the "theorem therefore fails." Similarly, on pages 250–251, theorems are formally stated and later shown "not to hold in general." This peculiar style of pedagogy is decidedly a novelty to the reviewer. It may at least serve to put the reader on his guard as to the fallibility of "what is written in the book." In the present instance the reader may be prepared for the actual error in the theory as presented on page 316, where the author makes a general theorem depend upon an equation which he has earlier proved only for a few special cases. His single reference is to the case of Gauss's field of complex

integers $a+bi$. Several errors appear on page 376; in the line below (2) and that above (3), m must be replaced by m_1; while the use of $\rho_1, \rho_2, \cdots$ for $\delta_1, \delta_2, \cdots$ is merely an oversight. At the bottom of page 255 the author speaks of introducing ideals into a number field.

Many of the proofs employed by the author in his case of quadratic fields are mere substitution of 2 for n in the standard proofs on algebraic fields of degree n. In one place he says: "This proof could have been somewhat simplified had greater use been made of the fact that the realm under consideration was quadratic, but it seemed desirable to give the proof in a form at once extendable to realms of any degree." The reference is to his three-page proof that every quadratic field has a basis! Now the real justification of a special treatment of the quadratic field lies in the fact that particularly simple proofs may be given and the reader made acquainted with an important example without the algebraic difficulties inherent in the general field. The above remarks will serve to show how the author has filled 300 pages with properties of quadratic number, without entering upon a discussion of the class number, characters, genera and other important topics on quadratic numbers.

In the matter of references the author has been particularly unfortunate. In a book barely entering upon the threshold of the theory, a scarcity of references would have been entirely justifiable. But to give hundreds of references to a certain report on the subject (excellent although it be) and to completely ignore the literature and not even mention the names of the discoverers of the theorems is against all scientific traditions.

L. E. DICKSON

SPECIAL ARTICLES

THE RELATION OF COLLOIDAL SILICA TO CERTAIN IMPERMEABLE SOILS

THE interpretation of recent soil bacteriological studies upon the Truckee-Carson Irrigation Project at Fallon, Nev., is in many cases difficult because of the impermeability to irrigation water on certain shortly defined areas. These impermeable areas support practically no crop growth, although the soil is very similar to that of the good areas in appearance and soluble salt content. During the past two years it has been my belief, based upon rough estimations of the silica that could be washed out from samples of soil from good and poor spots upon the United States Experimental Farm at Fallon, Nev., that at least in some instances the permeability and impermeability bore some relation to the occurrence of silica in a colloidal condition. Certain peculiarities of the behavior of soil samples from good and poor spots toward colloidal silica have been noted in the laboratory. These facts are only indirectly connected with our soil bacteriological studies and seem of themselves of sufficient interest to warrant publication at this time.

The following is a brief summary of laboratory results which seem to confirm the theory that in certain soils impermeability is associated with the occurrence of colloidal silica:

One-gram samples of good soil shaken in ten cubic centimeters of carefully dialyzed colloidal silicic acid of specific gravity of 1.0108 coagulates in from three to eight hours at 28° C.

One-gram samples of bad soil similarly treated not only do not coagulate the silica but hold it in a colloidal condition even after the check tube of pure silicic acid has coagulated.

The mixing of small quantities of calcium chloride, calcium sulphate or dilute acids with samples of bad soil before their addition to the silicic acid enables them to coagulate the tube of colloidal silicic acid in as short a time as that necessary for samples of good soil.

The treatment of samples of bad soil with calcium chloride, calcium sulphate, or dilute acids destroys their impermeable character, in some cases enabling water to percolate through them as rapidly as in the case of good soils.

In these experiments it has been found that the two essentials are, first, a high degree of purity of the colloidal silicic acid; and,

second, the preparation of the colloidal silicic acid at such a concentration that in its pure condition it will remain uncoagulated for about ten days. If the preparation is much more dilute than this it may fail to coagulate even with the good soils, while if it is much more concentrated it coagulates, presumably from mechanical reasons, almost instantly upon adding soil samples from either good or poor spots.

Whether these results may have a practical bearing upon the management of the refractory soils in question can be determined only by rather extensive field experiments. It is believed, however, that the action of calcium sulphate (gypsum) will improve these soils in the field as it has in the laboratory and that the crop-producing power of the poor areas may then approach that of the good areas.

Karl F. Kellerman
Bureau of Plant Industry,
Washington, D. C.

THE BOTANICAL SOCIETY OF AMERICA

The annual meeting of the Botanical Society of America was held at the University of Minnesota, Minneapolis, Minn., December 27 to 30, 1910.

The officers for 1911 are:

President—W. G. Farlow, Harvard University.

Vice-president—A. W. Evans, Yale University.

Treasurer—Arthur Hollick, New York Botanical Garden.

Secretary—Geo. T. Moore, Missouri Botanical Garden.

Councilors—F. E. Clements, University of Minnesota; C. L. Shear, Bureau Plant Industry; R. A. Harper, University of Wisconsin.

The following associate members were elected to full membership: O. W. Caldwell, University of Chicago; E. W. Olive, South Dakota College of Agriculture; R. H. Pond, Texas Agricultural Experiment Station; A. D. Selby, Ohio Experiment Station; M. B. Thomas, Wabash College; and the following botanists were elected to associate membership: Harley Harris Bartlett, Bureau of Plant Industry; Frederick K. Butters, University of Minnesota; H. L. Bolley, North Dakota Agricultural College; Merritt Lyndon Fernald, Gray Herbarium; Douglas Houghton Campbell, Stanford University; William Crocker, University of Chicago; Abel Joel Grout, Curtis High School, New York City; Hans Th. Guessow, Dominion Botanist, Ottawa, Canada; Frederick De Forest Heald, University of Texas; E. C. Johnson, U. S. Department of Agriculture; Frank D. Kern, Purdue University; C. H. Kauffman, University of Michigan; Ivey Foreman Lewis, Randolph-Macon College; Emile P. Mienecke, Bureau Plant Industry; Raymond J. Pool, University of Nebraska; Chas. V. Piper, U. S. Department of Agriculture; Leigh H. Pennington, Syracuse University; Carl Otto Rosendahl, University of Minnesota; Paul C. Standley, National Museum; Fred J. Seaver, New York Botanical Garden; Josephine E. Tilden, University of Minnesota; Chas.-Edw. Amory Winslow, College of City of New York; Herbert Hice Whetzel, Cornell University; E. Mead Wilcox, University of Nebraska.

The symposium on "Some Aspects of Plant Pathology" was held at the Agricultural College on Thursday and participated in by Professor L. R. Jones, who spoke on "The Relation of Plant Pathology to Other Sciences"; Professor B. M. Duggar, who spoke on "Physiological Plant Pathology," and Professor E. M. Freeman, who spoke on "Resistance and Immunity in Plant Diseases." These papers, with the discussions, will be published and reprints distributed to the members of the society.

At the close of the dinner for botanists, the conference on botanical teaching was held, in which Professor C. E. Bessey, O. W. Caldwell, F. E. Clements, J. M. Coulter, R. A. Harper and F. C. Newcombe participated. This discussion will likewise be published and distributed to the members.

Following are abstracts of the papers presented at the scientific sessions held on Wednesday and Friday afternoon.

Light as a Formative Factor in the Habit of Growth of Asparagus plumosus: Frederick C. Newcombe, University of Michigan.

The shoots of this house plant grow erect for a time, and then turn their tips to the horizontal position. Although this horizontal bend is geotropic, as shown by the klinostat, the process of bending is profoundly influenced by the presence of light. The new shoots which start up from subterranean buds are indefinitely nourished in the dark by the older shoots left in the light.

If a new shoot, a day before the bend was to be made, were covered by an opaque inverted cone of paper, the horizontal bend would occur without noticeable change from the normal. If the light were excluded two days before the time for the

bending, the time of bending would be delayed. Still greater delay in bending would follow an earlier covering.

If, now, a subterranean bud which has started to unfold be covered and caused to grow without ever being in the light, the period of erect growth will be greatly prolonged, the horizontal bend will never be complete, but, instead, there will be nutations up and down through an arc of usually 20° to 50°, these nutations lasting indefinitely.

This behavior may fall under one of two hypotheses: (1) etiolation disarranges the normal processes; (2) there is a weak inheritance of diageotropism which needs the supporting influence of light induction to give the usual form to the plant.

The Relation of Transpiration to the Water-content of Leaves in the Ocotillo: FRANCIS E. LLOYD, Alabama Polytechnic Institute.

During the summer of 1910 at the Desert Botanical Laboratory comparative volumetric and gravimetric data were obtained for transpiration in the ocotillo (*Fouquieria splendens*) during a period of twenty-four hours. The moisture-content of the leaves of this plant was also determined for a similar period on two occasions. The behavior of the stomata was determined by the measurement of 300 for each of six hours during the twenty-four. The following conclusions are drawn.

Comparative volumetric and gravimetric data show that, in the ocotillo, the ratio between the intake and outgo of water is not a constant, but that, aside from changes of secondary nature, the outgo is greater during the day than the intake. The reverse relation obtains during the night.

The amount of water relative to the dry weight of the leaves decreases till some time in the earlier part of the afternoon. After this time it increases till about four A.M.

This change in water content of the leaf explains at least in part the discrepancy between the income and outgo of water.

The decrease of water in the leaf occurs during the period of opening of the stomata. These organs are therefore not closely regulatory of the rate of transpiration.

Relation of Certain Fungi to Nitrogen Fixation: B. M. DUGGAR and LEWIS KNUDSON, Cornell University.

As a result of comparatively recent investigations in Europe and America it has been reported that many fungi growing in solution cultures have a power of "fixing" atmospheric nitrogen. It has seemed necessary to determine by more extensive experiments the amount of this fixation by fungi from diverse habitats grown under a variety of conditions. The following fungi were employed in two series of experiments involving about 400 flask cultures: *Coprinus comatus, Dædalia Quercina, Polyporus sulphureus, Trichoderma lignicola* and *Aspergillus niger.*

The culture media employed consisted of (1) a nutrient salt solution, such as used by other investigators, to which was added, in some cases, known amounts of combined nitrogen, and variable quantities of sugar; (2) filter paper moistened with preceding solutions; (3) quartz or graphite moistened with nutrient solutions; decoctions of mangel-wurzels; (5) dead leaves which were dried, powdered and moistened; (6) dried leaves, as in the preceding, with varying quantities of sugar; (7) decayed leaves or leaf mould; (8) leaf mould with varying quantities of sugar, and (9) leaf mould well aerated by including with it balls of filter paper. The nitrogen determinations indicate that there is no fixation of atmospheric nitrogen except possibly in certain cultures of *Aspergillus niger.* In many cases there is a nitrogen loss which is to be accounted for, usually, by the production of N_2.

In a third series of experiments additional fungi have been tested, and the experiments of other investigators duplicated. In the light of the results reported general indications were given respecting the possibility of nitrogen fixation by this group of organisms.

Cryptomeric Inheritance in Onagra: C. STUART GAGER, The Brooklyn Botanic Garden.

Reference was made to an abnormal plant of *Onagra biennis* that appeared in a pedigreed culture following exposure to radium rays of the ovule employed in producing the plant. The plant possessed two primary shoot-systems (rosettes and subsequent cauline stems) of equivalent value, but manifesting entirely unlike morphological characters. Photographs were shown, and various possibilities were suggested as to the cause or causes of the anomaly. That the effect was due to the exposure to radium rays was held to be possible, though not conclusively shown. The antecedent history of the plant, and the fact that hybrids between the two unlike halves manifested, in the F_1 and F_2 generations, the characters of only one of the parent shoots, was interpreted to emphasize the fact, already recognized, that the inheritance of a character and its expression are two quite different phenomena.

Sex Latency in the Gametophyte of Onoclea struthiopteris: F. C. Newcombe. University of Michigan.

The experimental work of Miss Wuist on the sex of the gametophyte of *Onoclea struthiopteris* showed, as published last year in the *Botanical Gazette*, that the female gametophyte may be made to give rise to antheridia. Miss Wuist's later work has shown that spores of the same species, which formed at first narrow ameristic plants bearing antheridia, subsequently developed heart-shaped proliferations at their apices bearing archegonia. To stimulate the outgrowth of the archegonia-bearing proliferations, the antheridia-bearing gametophytes were transferred from humus soil in pots to a Knop's solution, where they produced the meristic, heart-shaped, secondary gametophytes with their archegonia.

Reversible Sex-mutants in Lychnis dioica: George Harrison Shull, Station for Experimental Evolution, Carnegie Institution.

Hermaphrodite mutants were discovered in 1908 in cultures of *Lychnis dioica*, and the following year a report was made on the first generation cross of these with females and normal males. The present paper presents data from more than one hundred families in which these hermaphrodites were used, most of these families representing the second generation from the original hermaphrodites. It is shown that the hermaphrodite character is a modified male condition, not due to the presence of an independent modifying factor which was suggested by Correns, but obviously a modified condition of the male-producing gene itself. The hermaphrodite character is not transmitted by the egg, but only by the sperm. Among the offspring of these hermaphrodites have appeared a few normal males in such small proportions (a small fraction of one per cent.) that they can only be considered male mutants, since they also breed true to their male character. The appearance of hermaphrodite mutants in families produced from normal males and the appearance, in turn, of male mutants in families produced by hermaphrodites, suggest reversible modifications of a single gene rather than the addition of a gene to those previously present, and a subtraction of a gene from them. These results may thus have an important bearing upon the "presence and absence" hypothesis.

An Isolated Prairie Grove and its Ecological Significance: Henry Allan Gleason, University of Michigan.

Bur Oak Grove is located in Champaign County, Ill., and is about one by three miles in size. It is peculiar in being located at some distance from a stream and surrounded on all sides by prairie, while most of the forest tracts in central Illinois are along the larger water courses. The prevailing trees in the grove are *Quercus velutina, Q. imbricaria, Q. macrocarpa, Carya ovata, C. cordiformis* and *Juglans nigra*, with scattered individuals of other species. The variation in the composition of the forest indicates that it migrated into the region from the northeast. The grove is not continuous, but is broken by areas of low ground which contain permanent standing water. On the moraine north of the grove are found some plants which are regarded as forest relics, now growing in the prairie. It is concluded that the whole moraine was formerly covered with forest, which extended also some distance out on either side. Since the introduction of prairie fires this forest has been destroyed, except Bur Oak Grove, which is protected by the standing water against attacks of fire. The more general conclusion drawn is that forests were formerly of much wider extent in Illinois than at present, but it is distinctly stated that the prairies do not owe their origin to prairie fires.

Evaporation in its Relation to the Prairie Problem: B. Shimek, Iowa State University.

The fact that surfaces exposed to the south and southwest in the Mississippi Valley are treeless has been frequently noted. Where changes in topography are abrupt the transition from forest to prairie is likewise abrupt. The prairie plants are essentially xerophytic, the forest plants mesophytic. The former are found upon the surfaces exposed to sun and summer winds, the latter in sheltered places. Field observations on rate of evaporation on treeless and forested areas, made in western and northwestern Iowa, show that it is much greater on prairie surfaces than in the adjacent forest, and materially greater than on contiguous areas which had been covered with forest but are now cleared. This is true even in the vicinity of larger bodies of water. The results of these observations are presented in tabulated form, and are represented by curves. They show that evaporation increases with temperature and velocity of the wind, and that when the temperature is high the fluctuations in evaporation are caused by changes in wind velocity. The bearing of these results upon the prairie problem is discussed.

Structure of Adult Cycad Trunks: Charles J. Chamberlain, University of Chicago.

While the structure of the cycad seedling is

fairly well known, comparatively little attention has been given to the structure of the adult plant, doubtless on account of the difficulty of securing material.

In an adult stem of *Zamia floridana* 5.5 cm. in diameter the zone of vascular tissue was 2.5 mm. in width. In a plant of *Ceratozamia mexicana* with a stem 14 cm. in diameter the zone measured 5 mm. in width. In *Dioon edule* a stem 21 cm. in diameter showed a vascular zone 9 mm. wide. Compared with these narrow zones, the vascular zone in *Dioon spinulosum* is surprisingly wide, reaching a width of 7.5 cm. in a trunk 32 cm. in diameter.

In *Dioon spinulosum* there are definite growth rings but they are not annual, for not more than one ring is formed in a dozen years, or perhaps in twenty. Medullary rays are as prominent as in a dicotyl. *Dioon edule* also shows growth rings but they are not so prominent as in *D. spinulosum*. No growth rings were found in the specimen of *Ceratozamia*.

In none of these specimens were there any zones of wood in the cortex. It is possible that the periodicity which in *Cycas* produces a zone of wood in the cortex, produces in *Dioon* a growth ring resembling the annual ring.

Spruce Burls: HERMANN VON SCHRENK, Missouri Botanical Garden.

The author describes some burls observed in certain parts of Maine and Minnesota on the white spruce. They occur on all parts of an affected tree, either singly or in large numbers on one tree. The external appearance of the burl is described and their internal structure. Attention is called to the formation of diamond-shaped holes, which are probably the result of unequal strains.

The Origin of the Blepharoplast in Polytrichum: C. E. ALLEN, University of Wisconsin.

A dark-staining granule, the center of a system of radiations, appears in the cytoplasm of each cell of the penultimate antheridial generation. In previous cell generations there were kinoplasmic bodies of varying forms whose behavior was definitely related to spindle formation; but no structure that seems genetically related to the centrosome-like body that participates in the final division.

This central body divides; the two daughter granules, each surrounded by an aster, diverge until they lie at opposite sides of the nucleus, and a rudimentary spindle appears between them. The central bodies are conspicuous until about the time of the disappearance of the nuclear membrane; from this time on, they stain less deeply; some of the polar radiations disappear; and, although a granule can usually be recognized at either spindle pole which is probably the central body already described, its identity is often uncertain; and sometimes no such granule is visible.

After cell division is completed, a conspicuous body is again visible in each daughter cell, usually appearing to lie in the neighborhood of the former spindle pole; this body functions as a blepharoplast. There seems no reasonable doubt that the blepharoplast is identical with the previously present central body, which persisted during the division of the mother cell, although the lessened affinity of the central body for stains made it less conspicuous at certain stages.

The Method of Chromosome Reduction: R. R. GATES, Missouri Botanical Garden.

I have previously suggested that in some plants reduction takes place by telosynapsis, and in others probably by parasynapsis. Comparative studies have confirmed this view, but the difference between telosynapsis and parasynapsis is not believed to be of hereditary or phylogenetic significance. Rather is it merely a matter of cell mechanics, long, thread-like chromosomes usually pairing side by side and short ones end to end. The only essential and universal feature of meiosis is the segregation of the members of homologous pairs of whole somatic chromosomes. The function of synapsis is not to bring about a pairing of these homologous chromosomes, because they are paired throughout the sporophyte or soma. Neither is it to effect an interchange of chromomeres or other particles, since the chromosome is considered the unit of morphological nuclear structure; or even of "influences," since this could take place equally well or better in any "resting" nucleus. Synapsis is, therefore, not the final delayed act of fertilization, and is not of fundamental significance in the life cycle. It is, partly at least, explained by the change in the karyoplasmic relation which takes place during synapsis, owing to the fact that a segregation of chromosomes is intercalated between two ordinary mitoses.

On the Organization and Reconstruction of the Nuclei in the Root-tips of Podophyllum peltatum: JAMES BERTRAM OVERTON, University of Wisconsin.

Although a number of valuable papers, dealing with vegetative nuclear divisions, have recently appeared, notably those of Van Wisselingh

Grégoire and his students, Haecker, Strasburger, Bonnevie, Němec and Lundegård, a detailed account of the behavior of the chromosomes during rest has until recently been largely neglected. I have endeavored to follow in detail the various changes which the chromosomes of the telephase undergo during their passage into the resting nucleus, to follow their structural changes and arrangement in the resting nuclei, and also to determine how the visible chromosomes are reformed preparatory to division. During the passage of the chromosomes from the equatorial plate to the poles, they exhibit a progressive alveolation and vacuolation. Transparent spots appear in each chromosome. Each chromosome is composed of chromatic granules, closely massed in a linin substratum. By means of the progressive alveolation and vacuolation these chromatic granules are eventually separated. This process continues until conspicuous anastomosing vacuoles appear on the inside, increasing the size of the chromosome. These enlarged chromosomes often touch each other laterally, but never anastomose, as has been described by some authors. Each chromosome ultimately forms an independent reticulum. The reticulum of the resting nucleus thus consists of a number of these smaller elementary reticula. Conversely, during the earlier prophases of division, the chromosomes become more condensed and distinct and, joining end to end, give rise to the spirem, which is at first broad and reticulate, but eventually becomes densely chromatic. The mature spirem is not continuously chromatic, but consists of the individual condensed chromosomes united serially by visible linin intervals. In the writer's opinion the results strongly support the view of the individuality of the chromosomes.

The Nuclear Conditions in Certain Short-cycled Rusts: Edgar W. Olive, South Dakota State College.

Two general types of short-cycled lepto- and micro-rusts have been recognized with reference to the time of inauguration of the binucleate condition. In one type, the binucleate condition arises at the base of the young teleutospore sori. This type is illustrated by *Puccinia elegans*, *P. asteris* and *P. malvacearum*. In the other type, the binucleate condition arises at some indefinite point earlier in the life history, in the vegetative mycelium. Illustrations of this type are apparently more numerous.

Except the one species, *Puccinia elegans*, in which sexual cell fusions have already been worked out, the method of initiation of the binucleated condition is still problematical.

In two forms, evidences of occasional multinucleated cells were found in the young sori.

Uromyces Rudbeckiæ was found to present an enigmatical variation, in that all the cells, teleutospores as well as vegetative mycelium, were discovered to possess each but one nucleus. No explanation can be offered at present for this unique phenomenon.

Teratological Forms of Oxycoccus macrocarpus: C. L. Shear, U. S. Department of Agriculture.

A malformation of the cranberry plant, of both economic and scientific interest, occurs about Grand Rapids, Wis. Metamorphy of the floral organs is the most important and striking characteristic of the trouble. The flowers become erect instead of drooping, the calyx and corolla, and frequently the stamens and pistil, are changed into leaf-like structures. In the most aggravated cases the floral axis is elongated and the floral organs are represented by whorls of small leaves, or the flower may be replaced by a slender shoot bearing small alternate leaves. No insects or fungi have been found to bear a causal relation to the malformation. It is believed to be due, primarily, to prolonged and excessive stimulation of vegetative growth.

Rust of Tsuga canadensis: Perley Spaulding, U. S. Department of Agriculture.

Collections of the rusts occurring on *Tsuga* have been made for several years. Most of them have proved to be *Peridermium Peckii*. This ranges from Wisconsin to northern New York and Vermont, southward to North Carolina. It has been collected on the new host *Tsuga caroliniana* in North Carolina by Dr. A. H. Graves. The collections not belonging to *Peridermium Peckii* were separated into two forms: one on the young shoots, and the other on the green cones, in both cases on *T. canadensis*. The latter form is named *Cæoma tsugæ* sp. nov. The former presents no apparent specific difference from the latter, and it is for the present considered identical with it. Fresh material is necessary to determine this point with certainty, however.

A Plea for Organized Research in the Tropics: Pehr Olsson-Seffer. (Introduced by Wm. Trelease.)

A general discussion of the history of scientific research as carried on by various nations, with a special consideration of the conditions in tropical America and the numerous possibilities for work in all lines of botany.

American Botanical Societies and Meetings: W. F. GANONG, Smith College.

Report upon the results of an inquiry among a number of botanists regarding the present relations of the various botanical societies and the methods of conducting the meetings.

GEORGE T. MOORE,
Secretary

THE SECOND ANNUAL MEETING OF THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS[1]

THIS society had a very successful meeting at the Yale Medical School and the Sheffield Scientific School; the Physiological and Biochemical Societies met at the same time.

The following program was presented; unusual interest was taken in the discussions.

W. Salant, "The Pharmacology of Oil of Chenopodium."

A. S. Loevenhart, "Further Observations on the Action of Iodoso- and Iodoxybenzoic Acids."

C. W. Edmunds and W. W. Hale, "Physiological Standardization of Ergot."

L. G. Rowntree (with J. T. Geraghty), "Additional Data relating to the use of Phenolsulphonephthalein as a Functional Test for the Kidney."

H. C. Wood, Jr., "The Vaso-motor System of the Pulmonary Circulation."

C. J. Wiggers, "The Modifying Influence of Anemia on the Actions of some Well-known Drugs."

L. G. Rowntree and J. J. Abel, "Further Experiments in the Field of Specific Chemo-therapeutics."

T. S. Githens and S. J. Meltzer, "The Control of Strychnine Poisoning by Means of Insufflation and Ether."

C. W. Green, "The Action of Strophanthin on the Isolated Mammalian Heart."

G. Carr (by invitation), "The Action of Acetanilid on Cardiac Muscle."

W. Salant (with J. B. Rieger), "The Elimination of Creatin and Creatinin after the Administration of Caffeine."

W. Salant (with I. K. Phelps), "The Influence of Caffeine on Protein Metabolism."

C. Voegtlin (with B. M. Bernheim), "The Rôle of the Portal Circulation of the Liver in Bile Formation and Jaundice."

H. G. Barbour (by invitation) and J. J. Abel, "Tetanic Convulsions in Frogs produced by Acid Fuchsin and their Relation to the Problem of Inhibition in the Central Nervous System."

J. Auer and S. J. Meltzer, "On Intramuscular Absorption."

D. R. Joseph and S. J. Meltzer, "The Action of Sodium Chloride upon the Phenomena following the Removal of the Parathyroids in Dogs."

W. J. Gies, "Experiments with Salts of Aluminium and Beryllium."

The following new members were elected: S. P. Beebe, Cornell University Medical College, New York; R. B. Gibson, University of Missouri; P. H. Hiss, Jr., Columbia University; Paul Lewis, University of Pennsylvania; L. B. Mendel, Yale University; Isaac Ott, Medico-Chirurgical College, Philadelphia; J. H. Pratt, Harvard University.

The following officers were elected for the year 1911:

President—J. J. Abel.

Secretary—Reid Hunt.

Treasurer—A. S. Loevenhart.

Additional Members of Council—W. deB. MacNider, G. B. Wallace.

Membership Committee—S. J. Meltzer, C. W. Edmunds, Torald Sollmann.

The following resolutions were adopted concerning the recent death of Dr. C. A. Herter, one of the charter members of the society:

"By the death of Dr. Christian A. Herter, one of its charter members and founders, the American Society of Pharmacology and Experimental Therapeutics has suffered a loss which it can but inadequately express. Dr. Herter's breadth of view, his intimate knowledge and grasp of vital experimental problems, his clearness of expression and his valuable contributions to medical science made his connection with the society of great value to it. His encouragement and ever-ready assistance in the work of younger men, his appreciation of their difficulties, his own constancy in adhering to the high ideals of earnest and sincere work which he taught to them have made his death a personal loss to each individual member.

"The sorrow felt by the members of the society, however deep it may be, is but a small part of the general sorrow felt by the large number of men throughout this country with whom Dr. Herter came directly or indirectly in contact. The society desires to express its share of this sorrow, however, and it is therefore

"*Resolved*, that there be spread upon the record of its minutes this expression of its feeling of loss at the death of Dr. Herter, of its sincere

[1] New Haven, Conn., December 28–30, 1910.

appreciation of his work and of its deep admiration of his personal character.

Committee { REID HUNT, GEORGE B. WALLACE, A. N. RICHARDS "

HYGIENIC LABORATORY,

REID HUNT,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 477th regular meeting of the society was held January 6, 1911, with President David White in the chair and fifty-one persons present.

Two new members were elected and standing committees announced by the president.

Barton W. Evermann reported observations on the fly-catching habits of the common brown rat.

C. D. Marsh called attention to a report by Sars on crustacea from Lake Tanganyika, and stated that the list, so far as copepods are concerned, fails to bear out the theory that this lake is of very ancient origin.

The following communications were presented:

Notes on the Aspens: I. TIDESTROM.

The speaker gave the history and relationship of several American and European forms of the genus *Populus*. He showed that the western quaking aspen differs in several particulars from the eastern, and proposed a new name for the western form. A number of herbarium specimens illustrated the remarks.

Some Nesting Habits of Water Ousels and Cuckoos: NED DEARBORN.

The remarks were illustrated by photographs of the birds and nests. The observations on the water ousel were made in Spearfish Canyon, S. D., and in Santa Fe Canyon, N. M., during last summer; those on the black-billed and yellow-billed cuckoos were made at Joliet, Ill., in 1906.

A Recently Imported Enemy of Alfalfa: F. M. WEBSTER.

The alfalfa or lucern weevil (*Phytonomus murinus*) was introduced into this country, probably in the packing or in packages of articles of international commerce, some time prior to 1904, when it was first discovered by the entomologists of the Utah Agricultural Experiment Station attacking a small field of alfalfa in the vicinity of Salt Lake City, Utah. From this point it has since that time spread over the country northward to near Ogden and southward to beyond Provo and from a considerable distance westward of Tooele, very nearly to the borders of Wyoming.

The eggs are deposited chiefly in punctures made in the young stems by the adult beetles; the larvæ, as soon as they hatch, make their way to the tender growing crowns of the plants, feeding upon the unfolding leaves and tender stems, and thus prevent growth of the young plants. Later on in the season, after the insects have reached the adult stage, these still attack the alfalfa plants by gnawing the bark from the stem, thus destroying them.

In many alfalfa fields about Salt Lake, at the time for mowing the first crop of hay, the plants had not made sufficient growth to admit of mowing; while the second crop was seriously damaged by the feeding of the adult beetles as just described. Approximately, damage to the amount of a half million dollars was caused during the last year by this pest in Utah.

No thoroughly practical measures have been found for preventing the spread of the pest or very materially reducing the results of its depredations.

The habit of the adults in hiding away in baled hay, in fruit packages, or almost any other similar articles of commerce, as well as their attaching themselves to freight cars and hiding themselves in the vestibules of Pullman sleeping cars, makes their diffusion by railways almost unpreventable. Twenty-seven individuals were taken from the vestibule of one sleeping car attached to a train at Salt Lake City last July. Also, the adult insects fly about freely during the summer and being carried by the winds are also in this manner widely diffused.

The present indications are that the insect will make its appearance in southern Idaho, southern Wyoming and eastern Nevada the coming spring. Fortunately, alfalfa does not enter into international commerce as does cotton; therefore this insect is not likely to affect articles of international commerce. But over the western country, where it seems likely to diffuse itself and carry on its destructive work, there is much territory where alfalfa is the only crop that can be raised, and if this is destroyed the farmers will be placed in sore straits and confronted with a more serious problem than is brought about by any other insect known to occur in this country. Over a good portion of the country west of the one hundredth meridian alfalfa is the money crop of the farmers, and any influence tending to prevent or interfere with the cultivation of this, will constitute a calamity throughout that country.

The insect has no natural enemies excepting frogs and toads. Birds do not appear to relish them. No insect enemies are known, or have yet been discovered; and fungus diseases that attack similar larvæ in the east have failed to become established when introduced from the eastern part of the country.

D. E. LANTZ,
Secretary

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE first meeting of the society was held in the rooms of the zoological division of the Public Health and Marine Hospital Service on October 8, 1910, Dr. Stiles acting as host, Dr. Garrison as chairman. Mr. Hall was elected secretary for the year.

Dr. Pfender noted the publication of a recent article recording the finding of *Necator americanus* in New Guinea for the first time.

Dr. Garrison exhibited specimens of *Davainea madagascariensis* from man and read a paper, to be published in the *Philippine Journal of Science*, dealing with the case and describing the specimens. The material, consisting of one complete and four incomplete and headless specimens, was collected from an adult male native in the Philippines. It is the first case from this locality and the tenth recorded case. This case indicates a more or less general distribution of the parasite throughout the tropics. Cases occur in children and adults and the lack of records from any host save man since the parasite was first found in 1867 indicates that man is the normal host. So far the parasite has been recorded only from coast regions, but this may be due to inadequate investigation in the interior. Dr. Garrison's description of the anatomy was illustrated by photographs.

Dr. Stiles gave a talk on the International Zoological Congress at Gratz. He discussed the newly elected international committee on medical zoology and noted the following plans which the committee had taken up: the agreement on national repositories for collections dealing with medical zoology and for the deposition of type material; a working agreement between this committee and the Commission on Zoological Nomenclature to determine and fix upon the correct names of the parasites of man and later of those of domesticated and the more important wild animals; the securing of material from the various groups for the use of specialists; the location of existing collections and especially type specimens; the securing of better recognition of zoology in medical schools where work in tropical medicine is done, and the issuing of a model syllabus for such a zoological course; the collection of methods of technique; and the selection of corresponding members with a view to promoting harmony and cooperation and avoiding dissension and unwarranted criticism in zoological circles.

THE second regular meeting of the society was held in the rooms of the zoological division of the Hygienic Laboratory, December 1, 1910, Dr. Stiles acting as host, Dr. Ransom as chairman.

Dr. Stiles presented an abstract of an unpublished paper on rural sanitation, with special reference to the disposal of fæces. A proper disposal of fæces is the greatest single factor in combating zoo-parasitic diseases. Where the installation of a sewer system is not feasible, the dry disposal method has been considered the best. In this the fæces are covered with dirt or lime. The system depends on the cooperation of all of the members of the community for its success, and this fact constitutes one of the greatest objections to it. Children and the majority of the southern negroes can not be depended on to cooperate. The unsatisfactory character of this system being evident, efforts have been made to devise a satisfactory wet system. Many tests had given unsatisfactory results, but the wet system devised and described by Lumsden, Roberts and Stiles seems to have overcome the final objections. The paper dealt also with the objections to the dry system as they had been worked out at Wilmington, N. C. Some of the findings were as follows: (1) The sand under and around dry system privies is not safe five months after the last use of the privy. Sand which had been dried out twice showed two encysted larvæ on the one hundred and fifty-first day. Life was not demonstrated by movement, but the specimens were histologically perfect and could not have been dead more than a day or two if they were dead. (2) After four months the infection may be greatly reduced and in some cases perhaps entirely eliminated. (3) After five months in sand, and after drying out twice, live *Ascaris* eggs may be found after all the hookworm eggs and embryos have perished. *Ascaris* eggs were found apparently alive after 156 days. (4) Hookworm eggs were identifiable after 151 days. (5) When fæcal material is subjected to water decomposition for 70 days, most of the hookworm eggs die, but some are still alive. (6) No hookworm eggs were found alive after about four to five months in fæces and water. (7) It is probable

that hookworm eggs perish in three months in fæcal material in water. If this is proved, then the effluent from the L.R.S. barrel privy should be stored three months before using as fertilizer. The use of fæces as fertilizer is receiving especial attention for the reason that the commercial argument carries more weight with some people than does the idea of protection to human life and health. (8) In fæces decomposing in water, 80 per cent. of the *Ascaris* eggs are dead in four or five months, but some are still alive, thus outlasting the hookworm. (9) Chloride of lime in the proportion of a quarter pound to about ten quarts of water does not kill hookworm eggs in 22 to 40 hours. After four days the eggs are still microscopically normal.

Flies feed and breed in the dry system. In one place about 80 privies were examined. Although lime was furnished free, it was only used generously in three cases, and flies were breeding in these places as in the others. The fæces are collected in wagons and buried; burial under a foot of soil being recommended. The carts carry and distribute flies. Experiments showed that flies developed and crawled up to the surface from fly-blown fæces buried under six and a half inches of sand; they came through 17 inches in 24 hours; and flies issued after burial under 48 inches of sand. Flies were obtained even after burial under six feet of sand. In the last two cases, the sand used was not sterilized but was pure sand carefully selected. These are final arguments against the dry system.

The system favors the sporulation of amœbæ. Flies can bring to the surface and distribute amœbæ spores or typhoid bacilli. Under some circumstances privies may be more important than the manure piles as breeding places for flies.

Dr. Stiles presented a note on spurious parasitism. Small oligochætes were sent in from three different states in three cases recently, with the claim that they were passed in the urine. These are assumed provisionally to be cases of contamination. In one case, however, it was claimed that they were passed in the presence of a physician and into a clean receptacle. A specimen of a small snake, identified by Dr. Stejneger as *Storeria dekayi*, was exhibited. This specimen was sent in from Pennsylvania with the claim that it had been passed from the bowels.

Dr. Cobb presented a note on the abundance of free-living nematodes in the soil. The number per acre amounts to thousands of millions. Reckoning the average length at one and one half millimeters, a modest estimate, the nematodes in one acre would extend from Washington to Chicago if placed end to end. One genus feeds almost exclusively on diatoms.

Dr. Garrison brought up the question as to the desirability of designating certain tropical stations as repositories for zoological material connected with the study of tropical medicine. Dr. Stiles stated that the international commission hoped to take up that subject in the not too distant future.

Dr. Ransom gave a brief summary of a paper entitled "The Nematodes Parasitic in the Alimentary Tract of Cattle, Sheep and other Ruminants," to be published as a bulletin of the Bureau of Animal Industry. The paper describes 50 species, at least 30 of which occur in the United States, the species described representing 18 genera belonging in the five families Ascaridæ, Strongylidæ, Filariidæ, Angiostomidæ and Trichinellidæ. The Strongylidæ are divided into the subfamilies Strongylinæ and Metastrongylinæ, and the Trichinellidæ are divided into two new subfamilies. Railliet's rejection of the subfamily Strongylinæ, following the application of the generic name *Strongylus* to the so-called sclerostomes, and his substitution of the name Ankylostominæ was noted. A *Strongyloides* from the prong-horn antelope was noted as of particular interest. Members of the Angiostomidæ, to which this genus belongs, are characterized by a life cycle including two generations, one of free-living males and females, and another of parasitic hermaphroditic or parthenogenetic forms. In the species in question the parasitic adult molts repeatedly, and the eggs as passed lodge under the old cuticle and are carried away in the old skin when it is shed. It was noted that *Strongyloides longus* of the sheep is certainly identical with Wedl's *Trichosoma papillosum*. Two new species of *Capillaria* are described in the paper.

Mr. Hall gave a summary of a paper entitled "A Comparative Study of Methods of Examining Fæces for Evidences of Parasitism," to be published as a bulletin of the Bureau of Animal Industry. The paper gave the various methods used in examining fæces and indicated the application and limitation of each method on the basis of comparative studies. A new modification of technique which had been found more efficient than other methods was then demonstrated in the laboratory.

MAURICE C. HALL,
Secretary